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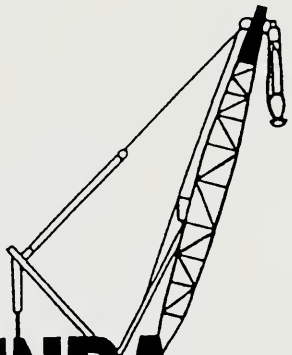

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of the

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Held at the

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September 24-27, 1995

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In Memoriam

Omer Denz

President

1982 – 1983

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JOINT SESSION

Monday, September 25, 1995

Opening Remarks

President Nordlund: As president of the Roadmasters and Maintenance of Way Association and on behalf of the American Railway Bridge and Building Association, I declare the 107th annual conference of the Roadmasters and the 100th conference of the B&B Association to be opened and in joint session. I welcome you all here today to Minneapolis.

I would like to thank you for your participation, attendance, and support in both these organizations. The program promises to be both interesting and problem solving.

We have a little work for you to do as we have in past conferences. One of the things that we ask you to do in addition to giving us your attention is to complete the conference survey forms. This serves two purposes, it gives us a participant profile of who is attending and it also gives us your ideas in terms of future programs and an assessment of what your feelings were in terms of the presentations for the day. We have different colored cards for each of the days.

The second thing that we ask you to do is fill out one of the subject cards for each association; Roadmasters is green and B&B is yellow. These subject cards are for the 1996 conference, but we are already thinking that far in advance. In addition, we do appreciate volunteers and we will be covering that a little later on in the conference. As of this morning, the attendance is 133 roadmasters, 81 B&B, 230 suppliers, and 64 railroad guests for a total of 508. We also have 86 spouses with us.

It is proper at this time that we pause to ask for divine guidance and inspiration prior to beginning this conference. At this time I would like to call on Mike Marlow, past president of the Roadmasters Association, to give the invocation.

INVOCATION

Michael J. Marlow

Past President of the Roadmasters Association

If you would bow your heads.

Oh Heavenly Father, we come to you in thanksgiving for all of the benefits you have bestowed upon us and our families. We thank you especially for the opportunities you have given us to gather in this setting with our peers where, in the spirit of fellowship, we can share the technical and practical knowledge you have blessed each of us with. We thank You for the leaders of our Associations who give of their time for the continuity of their respective groups and for the chairmen and guest speakers we will hear from over the next two and a half days.

We ask Your blessings on all of us during this gathering that our minds may be open to learning newer and better ways to do our jobs.

And Father, when this conference is over with, we ask You to grant us Your protection as we return home.

We ask these and all things in Jesus' name, Amen.

President Nordlund: Thank you, Mike. At this time I would like to introduce the Board of Directors. As I call their names, I ask that they stand and be recognized. I would also ask the audience to hold your applause until they have all been called.

First vice president, Kendall Koff, senior track and structures engineer, Amtrak, Los Angeles; second vice president, Wayne Russell, general director roadway maintenance and planning, Santa Fe, Kansas City, Kansas; and treasurer Ron Poulsen, senior project manager, HDR Engineering, Omaha, Nebraska. These are our officers.

For our directors we have Darrell Cantrell, engineer of track, Burlington Northern, Fort Worth, Texas; Dave Kelly, vice president maintenance, Illinois Central, Homewood, Illinois; Al Cloutier, division engineer Amtrak, Somerville, Massachusetts; Peter Murgas, manager reengineering, Norfolk Southern, Atlanta, Georgia; Ray Brousseau, manager track programs, CP Rail, Toronto, Ontario; Bob Davis, production manager ties, Southern Pacific, Redlands, California; Dwight Clark, director quality maintenance management engineering, Union Pacific, Omaha; Bob King, superintendent engineering maintenance, CP, Wood Dale, Illinois; Tom Long, manager engineering services, Indiana Harbor Belt, Hammond, Indiana; and Joe Riley, engineer standards, Metra, Chicago, Illinois.

You may now applaud. (Applause)

As this is a joint session, at this time I will turn the podium over to John Van Huis. John is president of the B&B association.

President Van Huis: Thank you, Keith. As president of the B&B Association, I would like to add my welcome to all the attendees of this conference. At this time, I would like to introduce the board of directors and ask them to stand. Could you please hold your applause until I have introduced all of them.

For senior vice president, Mike Bradley, project engineer, Conrail, Pittsburgh, Pennsylvania; junior vice president, Joe Lileikis, senior engineer of structures, Amtrak, Philadelphia, Pennsylvania; junior vice president, Bob Carter, general B&B superintendent, Burlington Northern, Springfield, Missouri; and treasurer, Don Lewis, assistant engineer of structures, Illinois Central, Homewood, Illinois.

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You may now applaud. (Applause)

WELCOME BY PRESIDENTS

President Nordlund: Thank you, John. As is tradition, we would like to welcome our sister association with whom we have had many years of a good working relationship. First, I would like to turn over the podium to Bruce Willbrant. Bruce is president of the American Railway Engineering Association and he will offer a few remarks.

Mr. Willbrant: Thank you, Keith, and good morning. I would to thank you for the opportunity to address this conference this morning. On behalf of the membership of the American Railway Engineering Association, I would like to extend congratulations and best wishes to presidents Keith Nordlund and John Van Huis, and you, the membership of the Roadmasters and Maintenance of Way Association of America and the American Railway Bridge and Building Association. Your contributions on the construction and maintenance on track and bridge and building has been outstanding and of great value to the industry.

Our three organizations along with REMSA have solved many problems in the past. We have added great value to the industry. We have found better methods and procedures for doing our work. The REMSA side has found better and higher productive equipment along with better, longer-lasting materials. Our society is changing. Things are changing in the railroad industry. We have new objectives and we have new focuses. However, a lot of them are just different wording.

On my railroad, we have objectives and goals. One of the biggest items today is our new department called risk management. Under that department of risk management we have safety. I think safety is the number one item for all railroaders today. It is not only what I call a humanistic item, but it is also a big financial item. We address many issues as far as safety.

I sat in the conference yesterday on training which is, of course, of most importance today. To get our people trained properly and to do the job properly is paramount. We also need better equipment to take the back-breaking work out of the work. We need to redesign tools. We have to get into ergonomics.

There are many, many issues to eliminate the injuries and, of course, the bottom line is we have to eliminate them for the financial reasons as well for the fact that we want everyone to go home at the end of the day as they left in the morning.

Another big item is customer satisfaction. Who are our customers? Our customers are the transportation department. We have to optimize our windows of opportunity. We have to reduce slow orders and keep slow orders to a minimum. We have to find better materials to increase our cycle time and reduce the on-track time. We are strictly working for transportation and we have to satisfy them. We are not in business to maintain track. We are in business to run trains. The quicker we realize that the transportation department is our customer, the better off we are going to be.

Of course another big item is what I always call shareholder satisfaction. Why is that? Let's face it, we are all driven today by the shareholders or Wall Street. We are driven by the stock analysts.

I think everybody in this room is aware of operating ratios. All the Class I railroads today are being driven by operating ratios. One has a lower one and then the next one tries to get down to that level. Of course we are involved in that also. I know on Conrail that I am driven by an operating ratio. I am also compared to the other railroads.

You make an operating ratio by growing revenue or reducing expenses. Sometimes when business is down, we have to reduce expenses. We have to find better ways of doing our work and that is where it always comes in together. We have to find better ways, better materials, and better equipment.

The last point that I will talk about which is very important is employee satisfaction. Satisfied employees are safer and more productive. In years past we never considered the employee at all. I guess that is why we have unions today, because of the way we treated employees. Today we must treat everybody with respect and we must have labor management teams to work on the problems.

We have come a long way on Conrail in doing that. We have been most productive by taking ideas from the working guy, the fellow out on the track doing the job. That has been the most productive. I think that a really new wrinkle today is considering the employee and taking the contribution from the lowest trackman out there on the track. These problems are not new. They are just focussed a little differently. By working together, they can be involved as in the past. We must work together to provide value to the industry.

We must prepare for the future. As I see it, it all comes down to excellence. We must serve our customers' needs.

In closing, I wish you a productive and successful conference which I am sure will happen looking at the agenda that you have for the next three days. Thank you very much. (Applause)

Mr. Nordlund: Thank you, Bruce. We do appreciate having you here today representing AREA.

It is now my pleasure to call on Stephen Lounsberry, president of the Railway Engineering Maintenance Suppliers Association better known as REMSA. Each year REMSA extends their hospitality to us through the support of the continental breakfast bar which most of us enjoyed next door this morning and we will be there again tomorrow. In addition, REMSA is also opening their hospitality suites each evening and we will be enjoying that also.

Mr. Lounsberry: Thank you, Mr. Nordlund. Members of the Roadmasters and Maintenance of Way Association of American, members of the American Bridge and Building Association, and guests. It is a great pleasure to be here representing the Railway Engineering Maintenance Suppliers Association also known as REMSA. We welcome you to Minneapolis. We want to convey our best wishes for a successful 1995 conference. I think we all know that our three Associations have enjoyed a long and fruitful relationship and a closeness not generally seen in other industries. When one of our groups takes an action, it thinks about how that action affects the other two groups. We want to be flexible because that working unity produces the best results for all involved and not just for one particular group or another.

At these conferences, REMSA has traditionally been the host of activities of a social nature and we have arranged for no less at this conference. In addition to the breakfast bars on Monday, Tuesday, and Wednesday mornings, we also sponsor a large reception on Tuesday evening from 6:15 p.m. to 7:15 p.m. in this room. All registered railroaders and their spouses are REMSA guests. REMSA members are opening 21 hospitality suites for you to enjoy and to provide a place where you can relax with friends and associates. Our members look forward to your visiting these hospitality rooms and I hope you will drop by also.

Of great response to REMSA is our large exhibition in September of 1997 in Kansas City. Norfolk Southern is lending REMSA space in the North Kansas City Yard for the outdoor displays which we appreciate very much. The indoor exhibits will be at the convention

center. It is my hope that there will be a large attendance for the show and your joint concurrent conference. I am sure that if we work together we can make it happen.

To Roadmasters President Nordlund and B&B President Van Huis, my congratulations for the past year of successes enjoyed by your associations and remember that REMSA stands ready to support both of your associations the best way we can. By continuing the close contact we have always had, I am sure we will meet the needs of the future. Thank you. (Applause)

President Nordlund: Thank you, Steve, and again our thanks to REMSA for their valued and close working relationships with both our Associations.

At this time it is my pleasure to introduce today's conference keynote speaker, Jack McBain. Jack is senior vice president operations of CN headquartered in Montreal. He joined CN's engineering department back in 1965 in London and has held numerous positions on various regions across the country as well as two previous positions at headquarters. In 1984, Jack was appointed regional chief engineer in the Mountain Region. In 1989, he was appointed district manager for Alberta. He then left the operations side of the house and moved to assistant vice president marketing ores, minerals, and metals business unit. In July of 1992, he was appointed chief engineer and then a few months later was promoted to position of CN's senior vice president operations. Jack McBain is a member of the operations general committee of the Association of American Railroads, the American Railway Engineering Association, the Association of Professional Engineers of Alberta, and the National Freight Transportation Association. He is also a director of the Railway Association of Canada, Toronto Terminals Railway, Shiwinigan Terminal Railway Company, CNCP Niagara/Detroit Partnership, Grand Trunk Corporation, DW&P Railway and CANAC. I might add that Jack is also a past member of the Roadmasters Association.

Please join me in welcoming Jack McBain. (Applause)

KEYNOTE ADDRESS

Jack McBain

Senior Vice President Operations
CN North America

Thank you, Keith. Good morning ladies and gentlemen. It's a pleasure for me to address you on the subject of risk taking in the railway industry. I was very happy that Keith mentioned in my biography that I was a past member of the Roadmasters Association. I chaired a number of committees and presented the results in conferences like this as many of you are going to do over the next two and a half days. That whole process and that experience gave me a lot of insight and, more particularly, a lot of very essential contacts throughout the North American railway industry which have served me very well in my career. So it was for that reason and because of my longstanding friendship with Keith that I was more than happy to be your keynote speaker here this morning.

At the height of the Second World War, General George Patton wrote a letter to his son who was then an officer cadet at West Point. "Take calculated risks," he said. That is quite different from being rash. Engineers and engineering officers would tend to regard taking calculated risks as the same thing as being rash. We do not take calculated risks on the safety or viability of a bridge or roadway. Our job is to build certainty based upon mathematical calculations and scientific knowledge into safe reliable and consistent structures. Yet we work in an industry that has always thrived on the visions of risk takers.

In the United States you have stories about the great early railroaders such as Vanderbilt, Gould, and Hannibal Smith. These men were very colorful, but they were forward looking in their vision of what the railroad meant to a growing industrial economy. Certainly they all took risks.

The history of Canada's railroad system is full of equally dynamic entrepreneurs. Two of the most colorful, William Mackenzie and Donald Mann, began by amalgamating many small prairie railroads into what was then known as the Canadian Northern Railway. The days of the railroad barons, though, the larger-than-life figures such as Vanderbilt, Gould, Mackenzie and Mann, are over. However, the men and women who run the railroad industry of the 1990s are no less visionary. Their abilities and grace under pressure are not measured by how many miles of track they have constructed through mountain passes or the number of small towns they have built up on the virgin prairies. Rather, they are measured by their ability to make the great business decisions in an environment of constant change.

At CN we see this every day. We see it in the way we help our customers respond to the challenges of selling in a global marketplace. We see it in the way that every department from operations to marketing and administration does more with less. How many times have you heard that expression? We see it in the way that we envision new ideas with their attendant risks that have become the norm rather than the exception in business practices.

It is not just the railway industry. The entire North American economy has had to accommodate a pace of change unprecedented in history. Business has two options: innovate or fade away. Innovation involves taking a leap into the unknown. It also involves taking risks, calculated risks, the success of which reveals management skill and expertise.

To be successful in the 1990s, a railroad must be focused on the need to build a customer-driven company in an environment of constant change and uncertainty. A railroad must have the determination to succeed as well as the experience and knowledge to assess risk and calculate the chances of winning. It must be capable of trying something new and innovative and pulling it off successfully.

There are many examples of CN being very successful in these areas. I have been with CN for 30 years and in that time with the company, I have never had so much confidence in management's ability to take the calculated risks essential for success in the 1990s. We have embarked on the most ambitious program of change and renewal in the history of our company. It is based on a simple three-part strategy: reduce costs, continue to provide excellent customer service, and invest strategically for future growth.

Bruce has mentioned that a lot of the things that we are doing today are a repeat and just a change of words on things we did in the past. These are three very simple strategic differences for CN, but they are most important and it is equally important that everyone in our organization follow them carefully.

We began the reduction strategy with the management structure itself reducing the levels from the CEO to the frontline supervisor from what was as many as eleven down to five. We followed that with a two-prong campaign to bring our labor productivity in line with the rest of the industry. On the one hand, we began a three-year program to reduce 11,000 jobs from the payroll by the end of this year. We are right on target with that. Between 1996 and 1999, we will be continuing at the level of about 1,000 job reductions per year.

At the same time, we entered into negotiations with unions over job security and flexibility. Once again, CN's management took a calculated risk, but we were confident in our position that railroading in the 1990s required a new kind of employee capable of responding to a variety of workplace challenges. The negotiations led to a strike earlier this year and subsequent arbitration which substantially awarded CN the labor contracts we had been seeking.

Another key element in the cost-reduction strategy has been to restructure the railroad by concentrating on four major freight corridors. We have reduced our feeder network by some 2,700 route miles and our plan in the near future is to reduce it by another 4,000 miles either through abandonment or sale to shortline operators.

A third element in our cost reduction has been better utilization of our assets. Our objective has been to cut our fleet by 6,500 cars by the end of this year, which is almost 10 percent of our entire fleet. We will be doing another 1,600 car reduction during 1996 primarily through improving car cycles. A big initiative on our part is to replace 543 more of our high horsepower locomotives with just under 400 new high horsepower locomotives. We will be replacing about half of them within the next five years and 25 percent of them by the end of next year.

Another key ingredient of our business strategy is customer service and strategic investments which are closely integrated. The major focus of our customer service improvement program has been to provide scheduled railroad service on certain routes. We plan to implement fully scheduled operations across the entire network by the end of next year. Although this wasn't designed initially with engineering forces in mind, you can imagine how it will greatly enhance the effective use of the limited track time that is available for engineering forces.

Furthermore, our on-time performance continues to build our reputation for reliability. Since March of this year, our intermodal trains have shown consistent improvement towards levels of 85 and 90 percent and there is every reason to expect this will continue in the future. The key to our success in that area has been the strategic investment of $100 million in a computer system capable of managing the progress of each shipment from coast to coast against customer goals.

Other elements of our strategic capital involvement have contributed to our target of scheduled rail service. We are concentrating on four major corridors: the east corridor from Halifax to Chicago, the western corridor from Lake Superior to the Pacific Coast, the west coast to Chicago corridor, and our transcontinental corridor. In 1995, our basic capital program or some 92 percent of our expenditures will go to those key corridors with the remaining 8 percent being invested on the feeder network which we plan to keep for the long term. Some of our major expenditures include over 300 track miles of new rail throughout the system. We will strengthen our bridges in Western Canada to handle the heavier axle loads of our unit trains and we will be replacing close to 800,000 track ties and over a million cubic yards of ballast.

Another major project this year and next year involves the rehabilitation of a major bridge structure in downtown Montreal. This bridge was first built in the middle of the last century and it was regarded as an engineering wonder of its time. It now requires an $8 million expenditure this year and $30 million over the next two years so that it can remain as a key structure in our CN network.

What I would like to emphasize here is that we make these investments with a clear eye as to their strategic importance to the company. They are all part of the strategy to reduce costs especially over the long term and provide quality service to our customers.

In each segment of our business strategy, reducing costs, improving customer service, and investing strategically, we have to rely more upon the managerial ability of staff at all levels in the CN organization. When we are speaking of managing risk, we are not talking only about the decisions made in the executive suites. If our objective, like yours, is to run a profitable, financially durable, and customer-focused corporation, everyone in the organization right down to the lowest person on the totem pole must be attuned to the need to recognize costs and market opportunities and assess the benefits. It is building on the statement that Bruce made earlier. All of us, all of you, have a key role to play in reaching these objectives in our industry.

If there is a key message that I would like to leave you with this morning, it is just that. That you all have a key role to play in meeting the objectives of your corporation to strengthen this railroad industry in North America. Managers and employees at all levels of the company must think and act as entrepreneurs keeping long-term objectives of the company in mind. For example, our engineering frontline supervisors are closely involved in day-to-day decisions on which assets need to be replaced and, more importantly, the most effective means of replacing them and ensuring that the job is done right the first time. They are fully involved in the capital budget process right from measuring and evaluating replacement track material to disposing of it in an environmentally-sound and cost-effective manner.

Line employees also play a role in helping CN cut its costs of operation. Last year in northern British Columbia, one of our tie replacement gangs operated successfully under an incentive plan. These are unionized employees operating under an incentive plan which gave those gang employees a direct financial stake in any cost benefits that were achieved by productivity without jeopardizing operating safety.

I do not overstate the case that we have undergone a wholesale change in corporate culture. Our job is not to run railroads, it is to run a business. Our challenge is not to administer, but to manage. This message comes through loud and clear in the changes that two of our operating functions have gone through recently, supply management and the mechanical department. Each of these departments changed their names from what used to be purchasing

and equipment. However, the changes go much deeper than simply changing the names. Each department examined the traditional approach under which they did their work. They looked for and found better ways to achieve their mandates. In both cases, the change was fundamental and far reaching. Purchasing went from a focus on unit costs to the implementation of supply management concept. The equipment department moved from an emphasis on ownership and in-house maintenance to one where leasing and out-sourcing are driving factors.

Last year, we cut our material acquisition costs by $14 million and this year our target has been to reduce $30 million from these costs. I am sure the supply side here today cringes when they hear those words and they hear the magnitude of cost reduction, but, in fact, I think we have been able to do it on a win-win basis while understanding clearly what the supply side has to offer and what the internal customers in the engineering department really require.

We have done more off-the-shelf purchasing and we are doing more direct deliveries. I think by working together closely we are able to drive out our costs while at the same time not make a major impact on the margins of our suppliers.

The mechanical department has embarked on a bold new vision for the purchasing and maintenance of rail equipment, particularly locomotives. As I mentioned earlier, the result is that CN will now require fewer locomotives to pull that same amount of freight. These diesel locomotives are, as you know, highly fuel efficient and require far less maintenance than the older models.

Another example of calculated risks to benefit both CN and its customers, one with an engineering focus, is the recent completion of the tunnel below the St. Clair River linking Ontario and Michigan. The tunnel is an engineering tour de force as you will see in a moment. It is a clear example of managing risk successfully. This involved building a new tunnel under sensitive third-party structures adjacent to an existing operating tunnel and fitting it between the bottom of the river and the top of the bedrock. I know you will find it very interesting when Keith provides a fuller description of the logistics and technical problems involved for the engineers who built it. Just let me say that the decision to build the tunnel was very controversial within CN, but the success of the tunnel is now indisputable. It was completed this Spring on budget and on time and allows CN to cut 24 hours off the transit time between Halifax and Chicago. We took a calculated risk and we were very successful with the results.

These are just a few examples of the enormous shift in CN's corporate culture that we have experienced over the past three years and the results can be seen in the company as a whole. CN's productivity shot up eight percent last year. We achieved the best profit improvement in the North American railway industry from a loss of $79 million in 1993 to a net number after tax of $245 million in 1994.

Now, while mergers are the talk of the United States railway industry, the privatization of CN is in the Canadian spotlight. After 75 years as a Crown corporation owned by the government of Canada, CN will be sold to the public this Fall. Privatization means that investors will make decisions about the value of CN based on financial and operating data. It means that we will have the freedom to continue to make the bold innovative decisions that are required to keep the company ahead of the game.

The privatization of CN is being led by a management team that is no stranger either to the importance of the process or taking calculated risks. We have come a long way from the days of the old railway tycoons like Mackenzie and Mann. However, we are coming around full circle. They envisioned a transcontinental railroad that would bring wealth and prosperity to Canadian businesses from coast to coast. They never saw it as anything other than a private sector concern. They happened to take some of the wrong risks in their venture and didn't survive, but today, 75 years later, we are hopefully much wiser.

CN is returning to the Mackenzie and Mann vision of a profitable and forward-looking

competitive railroad. We are returning to our private sector routes and we have the business acumen in our management team to keep CN in the private sector with a financially viable business for the future. Thank you. (Applause)

President Nordlund: Thank you, Jack. That was an excellent talk giving the members and guests an insight into CN's accomplishments and future vision. Certainly your comments in regards to managing risk is applicable to us all at all levels of the organization. B&B and Roadmasters do, in fact, play a key role, as Jack talked about, and are very familiar on a daily basis of managing risk.

The next item on the agenda today will be given by me. I notice it is the first special feature of the day and of the conference. The program title is the final update on CN's tunnel under the St. Clair River. I know that we do not usually use the word "final" or we are at least very reluctant to use it, but this is a final version.

FINAL UPDATE ON CN'S TUNNEL UNDER THE ST. CLAIR RIVER

D. Keith Nordlund

Project Manager
CN North America

To put it into time perspective, it was three years ago in Chicago that I presented what was a slide presentation to the conference on the "Proposed New Tunnel." Back then, we were in the middle of about a 15-month preparatory phase. We were doing detail design and we were also slogging our way through the environmental process both on the United States and Canadian sides. At the same time we were fabricating the tunnel boring machine.

Time has passed and now we have been running train operations through the new tunnel for almost half a year. The video that you are going to see is an engineering review with the focus on engineering. It brings out the risks that Jack talked about, that being the engineering risks as opposed to business risks. Of course, the object and the goal of the project was not to build a tunnel, but to streamline a vital CN link between Canada and Chicago with, of course, Chicago being a major hub and a key factor in CN's future.

With those few opening remarks, I will show the video and I will be more than pleased to try and answer questions afterwards.

(Whereupon there was a video presentation)

President. Nordlund: Thank you very much. (Applause)

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Mr. Murgas: At this time it is my pleasure to again call on Steve Lounsberry, president of REMSA, to give us an update on the new and innovative things going on in the supply industry.

REMSA PRESENTATION

Stephen Lounsberry

President

Thank you, Pete, and good morning ladies and gentlemen. On behalf of all the members and officers of REMSA, may I again start by extending a warm and sincere welcome to the conference. Your attendance and contribution to these technical sessions are absolutely key to the continued development of the many technologies of today's railroads. Most of us who have been attending these conferences for a number of years are able to see a significant change in the very nature of these meetings, a change that can be summed up as a move from shared experience to applied technology. While it is still valuable to hear how others have tackled the big problems of construction and maintenance, it is obvious that the focus is now on the imperative need to maximize the use and development of complex new technologies in running the railroads.

If you recall, we have referred to our REMSA exhibition as Technology 2000 for several years now. That title reflects our acute awareness of the need to reach outside our railroad experiences and practices to find solutions to the problems that we will continue to face in the next century if not in the coming years and months.

Applied technology, or more specifically how we must direct and control the application of technology, is the subject of my remarks to you this morning. We, members of the Railway Engineering Maintenance Suppliers Association, have found ourselves as deeply immersed in fast moving technical advances as any industry of our time. You don't have to work in Silicon Valley and build Mach 3 airplanes to be high tech any more. Virtually every one of our 213 REMSA member companies market and use technologies that were not in existence three to five years ago.

Technologies in our products and services, costs, and work saving capabilities that were unthinkable only a short time ago have had a marked affect on the reasons we are here today and the mission we really need to accomplish with these conferences.

REMSA as an organization, as well as each of the REMSA member companies, have an important role to play in helping each of you to gain the most benefit from the application of all the technological advances we have now and are preparing for the future.

Before I detail some of this, let me outline some of the key areas of REMSA's activities and services you should be aware of and use. REMSA is 30 years old this year. When it was formed with a few of the leading manufacturers and service firms of the 1960s, both the management of the railroad and engineering communities and the REMSA companies were facing a growth spurt in several major services of technological application.

Communication and information management systems had arrived in the early phases and the evolution of what we now call the chip. We all had a new language to learn. New materials and processes and materials processing concepts were emerging from the space programs and laboratories, from the major chemical and metallurgical companies, and from the science departments of leading universities. Enhanced and hybrid materials, new families of plastics, and the early forming of our present composites were making their appearances.

The foresight of the founders of REMSA revealed the need for approved ways for members to establish the same higher levels of technical communication that some of the professional groups of engineering and science had developed. The ability to communicate the increased flow of new information between you, our markets, and among ourselves in the industry was to be of the utmost importance.

Every avenue from direct personal contact in such things as REMSA receptions, the highly structured conferences, and expanded exhibitions will be explored and developed as a much expanded two-way flow of information between you, our customers, and the REMSA member engineers and designers was begun. Government agencies and industry associations such as the Roadmasters, B&B, AREA, and AAR would be brought into the communication loop with REMSA. The need for up-to-date information was growing at an increasing rate and the time allowances for the information to reach the designers was shrinking as it still is.

REMSA is probably best recognized for the equipment and service exhibition it has run over the years. The major event held every four years provides a hands-on opportunity for exploring the newest technologies and a head-to-head communication platform for you and the behind-the-scene designers and engineers of REMSA. The objective is to develop improvements and refine the application of the products and systems.

In the interim years at the AREA technical conference, we offer a condensed version of the maintenance how-to version of the major show to keep everyone informed of the progress and developments underway in our products and services and, most importantly, to keep the communication channel open with you, the actual user of these products and services.

In effect, the flow of communication between us is the main thrust of my message to you this morning. I want to point out some very critical areas where improvement will not only unlock the doors to future technology, but where failure to improve our communication will have a severe and negative impact on our ability to sustain your needs in the next few years and into the next century.

Before that, let me point out one more area of REMSA's activity that is not very well known but can be of great value to all of us. I am speaking of lobbying our governmental structures such as Congress and bureaucracies. This is a new but very important REMSA activity. There is much media hype these days on the subject of lobbying efforts with most of it aimed at discrediting groups and organizations who make their needs and opinions known to Congress. The media in particular and all of us in general need to remember that we do not belong to the massive power structure inside the belt way. It belongs to us. Lobbying is not a privilege or an undercover covert activity. It is an obligation that falls most heavily on those who have the most to do with the growth and preservation of our economy — the business managers who fuel the engine of our economy.

We support and work directly with the rail supply service coalition as a joint effort of five railroad supply organizations that adds considerable weight to our arguments in favor of the rail industry. Two key areas are the pressure from the trucking industry to increase federal truck size and weight limits and our National Transportation Policy itself. AAR sees the big trucks as costing about a 21 percent loss of gross revenue from the rail industry. This is in the face of the damage to the highway infrastructure and the safety factors for our roads.

Secondly, although intermodal service is broadly seen as the best approach for reducing highway damage and accidents, the National Transportation Policy itself fails to recognize the facts. The railroad is operating under a heavy tax burden that provides safer, energy efficient transportation. The national network of highways is totally tax supported. Congress needs to re-think national policy on these issues.

I have one final comment on the activities and accomplishments of the REMSA organization and members. The railroad association groups such as Roadmasters, B&B, AREA, and others have done an excellent job over the years with the development and maintenance of the economy concept of intra-industry communication and problem solving. REMSA manu-

facturing and marketing members have participated on many if not most of these committees and will continue to make their time and efforts available to further the work done by them.

That, in a condensed form, is a picture of REMSA today. As we work towards Technology 2000, we will continue to be one of the strongest and most important tools you have at your disposal.

Now in the time remaining to me, I would like to move the focus even tighter on the subject of communication and expand on some of the facts that are not only open to us, but which are absolutely essential if we are all to succeed in our jobs.

Here are some of the areas that REMSA found the most need for more detail and help from you. The result of better communication in these areas will be better product and service performance and, in many cases, improvement of the life cycle cost picture to the railroad. The abilities of individuals to aid in the communication of important information obviously is related to job functioning and company procedure. However, even in a formal way when the need is perceived, each of us can find ways to make a contribution. The responsibility for establishing and enhancing the flow of quality communication on both the railroad and supply sides falls primarily on the shoulders of management with the different levels of job functions, but also on the service user of every product.

This message is delivered with a caveat, if the shoe fits, wear it. Along the same footwear line, if I may borrow a Nike slogan and ask that all of us adopt it, "Just Do It," and we will all play a better game. A good starting point is specifications for both the job to be done and the product to do it. The need for detailed and comprehensive specifications increases dramatically as we move through the various levels of products and job functions.

One benefit gained from the technological evolution is it has made it possible for us to choose whether to build new products or to modify existing products for more specific dedicated service. Only accurate and detailed tests will result in products that will meet your expectations for performance and for costs.

In the spike maul and ballast fork era, good steel and a strong handle may have been enough to ask for, but not to meet the expectations for high technology rail fastener systems or for high production value maintenance machines. It requires expert specifications for the design and production requirements increased exponentially and in complexity and volume.

For a few products and services, such as the more generic function items, the user can easily adapt his own functions and procedures to the existing equipment or service offering. These frequently are items that serve more than one market and can be purchased off the shelf on short notice and at competitive prices. A truck or computer would fit this category. But when special application requirements restrict the product to the railroad market only and then maybe to a limited number of railroads, there are still other factors added to the need for specifications, notably short and long-term volume expectations and delivery lead time. Every supplier has to anticipate these factors to set both the scope of the product development and cost to make production forecasts.

Many of us on the supply end have experienced the problems rising out of misinformation about delivery of volume requirements. To a large degree, a manufacturer rolls the dice when he anticipates orders for a product in a given period. Too much inventory left on the shelf raises overhead and results in cost increases. But as the old timers used to say, you can't sell from an empty wagon. Too little product to satisfy the market results in insufficient inventory, missed deliveries, and lost business. The best solution to both ends of the problem is better marketing information in advance on which to base production and inventory plans.

That information has to come from you, the market. Now if the manufacturer fails to go out and get the information, the blame is his and he deserves loss of profits. However, if the market is reluctant to supply that information or produced information based on incomplete or inaccurate internal fact gathering or if the market fails to make purchasing plans known in advance, the market will share in the loss in the form of fewer good products and higher costs.

It is obvious that teamwork and the building of a better flow of effective communication will benefit both buyer and the seller.

The third opportunity for product development and improvement through enhanced communication centers on the constant struggle between costs and value. The development and adaptation are more sophisticated and expensive technological concepts have a price. That price, as always, exerts the strongest impact at purchase time. Purchasing decisions are not made any easier by rising product costs in an atmosphere of generally increasing economic pressures on all fronts. But there is another side to the coin. It is becoming more and more apparent that if technology is increased per cost, it is also offered significant advantage in the life cycle on total costs. Reduced labor costs, expended productivity, faster and safer operations, and the extended life and service from the other asset services are increments of that value that the higher tech tool or complex service exchanges for a higher first cost.

In its most basic, yet not always recognized form, the life cycle cost measurements technique is applied only to differentiate the most superficial qualitative difference between similar products. But if the concept is extended to its full potential by bringing better and more definitive service description to the original product specs, it is possible to achieve very favorable and accurate cost versus value measurements.

Specifications of expected values is key to recognizing and evaluating them at purchase time. A good proven life cycle cost profile for a product is an insurance policy to both the manufacturer and the user. They both have to justify their investment and only the life cycle costs can really do that. But an excellent or even barrel life cycle history for a product is only partially the result of design and manufacturing quality.

Life cycle cost is greatly affected by the people in the field who use them. The how, when, and who of its use can turn a superior product into a marginal life cycle investment or make a moderately good product look far better than the expectations held for it.

The "how" factor includes how the product was installed or put into use.

Very often for the high level of high tech products now offered, product installation requires not only a high skilled degree and the mechanical realm by capability and understanding of human or ergonomic factors and interpreting design parameters of the product.

The "take it out of the box and turn it on" approach does not work very well anymore in our high tech world. An off target start can result in an undeserved poor life cycle cost record for the product.

The "when" element of a product can relate to both the start up process and to the criteria for the use of the product. An over-ambitious plan or an excessive adaptation of results can put a product in service when conditions absolutely prohibit success. In my own company's case, we have seen a single wayside lubricator put into a curve situation where two of them would not have been enough or where rail relay track structure maintenance done first would have allowed a full return on the benefits of the lubricator.

The "who" condition deals with the assignment personnel but not only takes into consideration the experience, job knowledge, and personal judgment capabilities of the operators, but strongly subjects the degree of training that should precede the use of the product. In these times when manpower is stretched many times over to get the work done, there is a great risk that a product, through no fault of its own, will fall short of expectations and fail to achieve acceptable life cycle and cost levels because of a lack of training of the people who use it.

Through all these situations of when, how, and who, the establishment's open and comprehensive two-way communication between supplier and end user is an answer to a majority of the problems. Where there is a history of purchasing products and service based solely on lowest first cost, usually can be found a history of higher than normal life cycle costs resulting from a mix of these problems.

Our common goal has to be better products offering better value through mutual cooperation and development and application. We certainly believe the best is yet to come in the growing use of technology and building and maintaining our nation's railroads.

Again, thank you for allowing our participation. (Applause)

Mr. Murgas: As always, it is very interesting to hear about the mutual opportunities for the railroad industry and the supply industry and we thank you for your time and efforts as well as your Association's hospitality.

Our next feature is entitled Intermodalism and the presenter is James N. Denn.

Mr. Denn was appointed commissioner of the Minnesota Department of Transportation in November of 1991. Prior to working in DOT, he served as a deputy commissioner in the Department of Labor and Industry. From 1972 until 1991, Commissioner Denn headed the Minnesota Trucking Association in St. Paul. He has also held previous management positions with both Honeywell and Northwestern Bell.

Mr. Denn is a member of the board of directors of the American Association of State Highways and Transportation Officials. He is an executive committee member of the National Research Council, Transportation Research Board, and he serves on the subcommittee for NRC Oversight.

In addition, Commissioner Denn served as a cochair for the Minnesota Guide Star Executive Committee and is a member of the Minnesota Environmental Quality Board, the University of Minnesota Center for Transportation Studies executive committee, and the Board of Minnesota Safety Council. The commissioner is also a graduate of the University of Minnesota.

Please join me in welcoming Commissioner Denn. (Applause)

INTERMODALISM

James Denn

Commissioner
Minnesota Department of Transportation

Thank you very much for the kind introduction. It is a pleasure to be here with you today. You will note by the introduction that part of my past career is with trucking, but I can tell you that throughout that time even though we didn't always agree, I always recognized a common purpose on what we are about. So I feel very privileged to share a few minutes with you today.

I will talk to you about more than just intermodalism, but I do want to focus on that a little bit. First of all, let me bring you greetings from the State of Minnesota and particularly our Governor Arne Carlson. This is a bittersweet day for us in Minnesota. While we are gathered here to talk about some important things, just across the city our former governor Rudy Prpich's funeral mass is being said so our thoughts are with him and his family, as well.

It is an honor for me to be speaking to people responsible for building and maintaining, on a daily basis, the world's greatest railroad transportation system. I have recognized the ebb and flow of what is happening with the real strength of this nation being the ability of the rail industry to recognize those trends and respond.

As the sole representative from Minnesota on your agenda over the next few days, I would like to take this opportunity to give you a snapshot of how important rail transportation is to the economic vitality and future of this state and also offer a brief review of some of the major rail transportation issues we are facing. This includes our effort to support and promote intermodal freight movement. Like most states west of the Atlantic Coast, the railroads played a principle role in Minnesota's settlement and development. The first railroad in Minnesota was built in 1862 and by 1930, the state's rail system was more than 9,300 miles. Without the railroad, Minnesota's iron range, its taconite industry, the timber industry, our agriculture industry, our ports and waterways, our manufacturing industry, and, in fact, our entire state economy would not be as successful as it is today.

Today, Minnesota's rail system consists of approximately 20 railroad companies and 4,800 rail miles with nearly 2,300 miles serving national and international connections, 1,200 miles providing regional service, and just more than 1,000 miles providing strictly intrastate service. More than 200 million tons of freight move in Minnesota annually and rail is the State's leading form of transportation responsible for the annual movement of an estimated 70 million tons. Taconite, coal, and farm products represent nearly 90 percent of the state's annual rail tonnage.

The rail industry in Minnesota, like the industry nationwide as I understand it, is facing challenges of increased competition, downsizing, rail line abandonments, and aging infrastructure. But in Minnesota we are also encouraged as the industry is digging in and performing the unpleasant task of trying to build increased capacity to meet an increasing and growing market. Grain volume is up. The taconite industry is stabilizing and coal movements continue to grow. Intermodal movement is growing as well.

Having mentioned intermodal, again, I would like to tell you about an exciting endeavor that is going on in Minnesota. In 1990, 13 percent of all products by value shipped from Minnesota to points around the U.S. and 11 percent of all products by value delivered to Minnesota were moved by intermodal shipments which is a doubling of such shipments since 1981. Minnesota has six truck intermodal rail terminals including two here in the Twin Cities and four others in north and northwestern Minnesota at Duluth, Thief River Falls, International Falls, and on the state line of North Dakota and Grand Forks.

Major intermodal facilities without ports are also located in Minneapolis and Duluth. Growth in the use of intermodal freight service is creating capacity problems for our existing facilities. In response, MINN DOT is not responsible. We don't have anything to do with Class I railroads, but we have a lot to do with regional railroads. However, we like to work in partnership with Class I railroads and do what we can to help. In that capacity, MINN DOT has formed a partnership with the Twin Cities Metropolitan Council, Burlington Northern Railroad, the Canadian Pacific Rail System, and the Union Pacific Railroad.

This partnership is pursuant to the Minnesota Intermodal Railroad Terminal Study, which we refer to as MIRTS, to forecast the future growth in intermodal shipping in the Twin Cities area to the year 2012 to assess the capacity of existing intermodal terminal facilities. To meet that forecast, the first phase of the MIRTS effort has been completed. The MIRTS partnership is now concentrating on finding a 165-acre intermodal terminal facility that has a

capacity to handle a projected 530,000 lifts per year. The partners are also working to develop a financial package and original strategy for creating a multi-user facility. The MIRTS partnership is committed to make recommendations to respective management in the fall of 1996. So we are very encouraged by the MIRTS progress this far and are excited about the future. However, I would be misleading you to tell you that to the extent that the state's financial participation is required, that this is a slam dunk. Remember like every other jurisdiction in the present time when the 1997 legislature deals with the recommendations they are asked to, we will need the full support of this industry to make it a reality.

Another program that I am very proud of is the Minnesota Rail Service Improvement Program. It is designed to improve rail service in Minnesota by providing state funds in the form of loans and grants for the rehabilitation of rail lines and other rail service improvement projects. The rail improvement program involves financial participation by rail shippers, the railroads, the state, federal, and local rail freight assistance program. Over the next three years, Minnesota has committed more than $16 million to the rail improvement activities under this program.

We are also very active and have targeted approximately $4 million per year to improve the safety of all the state's rail crossings at public highways. We have 5,100 of those and the funds are used to install signals and gates and upgrade crossing services and improve signing. Minnesota has made a special effort to improve visibility at grade crossings by installing some state-of-the-art reflective signs at all crossings in the state and we're experimenting with innovative pavement marking tape and crossings with hard surface approaches. We expect to complete these improvements to all public rail crossings either next year or at the latest by the end of 1997. We are also hopeful that the significant commitment we have made with our resources to both developing and applying advance technology will lead to some further advances in crossing safety as well; particularly that advanced technology as it relates to intelligent transportation systems.

High speed rail is another issue that has been alive and around in Minnesota. We have passed legislation the last couple of years supporting completion of a study that started service between the Twin Cities and Chicago. In 1990, Minnesota, Wisconsin, and Illinois conducted an initial feasibility study and the answers came up that, yes, it does make some sense to pursue this. It would connect the major cities in Wisconsin to Minnesota and Wisconsin to Chicago. Technologies of up to 300 miles per hour in land speeds were studied. The first step concluded that a line connecting Rochester, the Twin Cities, Lacrosse, Madison, Milwaukee, and Chicago was, in fact, feasible. The Minnesota legislature has promised $500,000. We have estimated it costs $2 million to do a decent study. Our Governor has said and our legislature has said, "okay."

Wisconsin is the other partner and I can tell you very frankly that Illinois is not interested at this point in time to put anything into that study. They have pretty much what they have been after at least as far as the state government is concerned. Proposals have been in the Wisconsin legislature for the last year and a half or so and no action has been taken yet. As soon as Wisconsin does act, we can then go to the federal government and seek the matching funds to complete the funding for the study. We encourage Wisconsin to pursue that and we are hopeful that we can get the study underway in the next year or so.

I understand that light rail transit is also of interest to some of people attending this conference. It's another alternative that we continue to look at. The Twin Cities area has been examining this potential for a number of years. In early 1993, MINN DOT proposed a construction of a $200 million plus LRT to run approximately 18 miles from downtown Minneapolis to the southern suburbs. This is the first time in history that a DOT, a former highway department now a transportation department in this state, commissioner has announced support for LRT. It has not been without significant controversy and the lack of state and federal funds have made the opportunity to move ahead with that implausible at this

time and in the immediate future. We will continue to assess it and explore opportunities to deploy that technology.

On another point that may be of interest, Minnesota is currently deep into a study of whether to build a new airport or to expand the existing facility. This seven-year study has been conducted by the Metropolitan Council and the Metropolitan Airport Commission and it is in its final stages with the final recommendations scheduled to be issued to the state legislature in July, 1996. Of course, projected growth in air freight movement is a factor in this decision process. Air safety is also a factor. Air freight operations at the current airport are expected to grow significantly by the year 2020, both in terms of actual tonnage and in the percentage of total airport operations. One option that has been discussed publicly, but is not under consideration at present in this particular airport study, is to shift a significant amount of air freight business to the Rochester, Minnesota, airport approximately 90 miles southeast of the Twin Cities and to facilitate that movement by high speed rail. It makes a lot of sense to me. In fact, I have promoted it, but the railroad officials decry that particular proposal so I think what is left on the table is to either build a new airport 25 or 30 miles southeast of where the current airport is situated or expand our existing facility.

This also will not be a non-controversial issue. The Denver airport was said to cost approximately $5 billion and someone estimated this to be at $4.4 and I don't think that estimate includes any of the land access costs to purchase road rights-of-way, rail rights-of-way, or the development of that right-of-way into actual transportation corridors. My guess is the actual cost of the airport is significantly higher.

Highway funding may be another issue that you are interested in. I probably would be remiss if I didn't mention at least that we are exploring the possibility of raising the state gasoline tax to fund highway construction and maintenance projects. The gas tax increase proposal is mostly focused on an increase of five cents per gallon on the state tax. This has been introduced and highly debated in the state legislature each of the last four years. Our current tax level is 20 cents a gallon which applies equally to cars and trucks. We expect similar efforts to be made in the 1996 legislative session although that is an election year for both our house and senate and that's an environment that usually breeds significant conservatism.

In Minnesota, revenues and current tax levels are adequate to meet the minimal repair, maintenance, and limited capital improvement needs of our state highway system. However, to move forward for needed major reconstruction or new construction of highway corridors or aging bridges, especially for our high cost metro area highway systems, more funds will have to be found than are currently available.

One area we are exploring to meet our highway and bridge needs is the construction of toll roads. In November, we will receive our first private sector proposal for toll road projects. Next spring some of these projects will likely be selected for further consideration and developments. A decision on construction, go or no go, will be made in 1997.

Let me close my comments on the department with saying I was very intrigued just catching the last part of the previous presentation on life cycle costs and life cycle values. We don't use the same terminology, but I can assure you that the Department of Transportation in the State of Minnesota is like state departments of transportation in most other states of which I am aware. We are committed to try and rebuild ourselves and follow the example set by the private sector and do the right thing in the right way by making quality decisions and by turning out quality products and services so that you as taxpayers get the right bang for your buck. We are very proud of what we have accomplished so far and we will continue to tow that line. We think it will help us as we address the significant rail and transportation issues facing our state today.

Minnesota is 1,200 miles from the ports of New York and New Orleans, 1,800 miles from Seattle, and 2,000 miles from Los Angeles. We are among the national and international

leaders in the production of bulk agriculture commodities, taconite, and timber. Our Twin Cities area is the anchor economic center of the upper Midwest. I am all too familiar with the presentations of people who I have great respect for like John Vickerman and his presentation on intermodalism and opportunities and challenges. I can tell you that we are paying attention to those considerations. We rely on you to be successful to help our state be successful.

Thank you for all your past contributions to that quality rail service and we will continue to be a vital component of our state transportation network. Minnesota's economy is vibrant and growing today largely because of past and present service provided by your industry. The state's future economic success is dependent upon that service. Minnesota looks forward to working with you to meet those challenges both today and tomorrow. We have an important stake in your being successful as I have said.

I hope now that you know a little bit more of what we are doing here in Minnesota. I greatly appreciate the attention you have given me. Again, I thank you for coming to Minnesota. I hope that you have the opportunity to do more than sit in this hotel. The weather is great outside right now and I hope that you have a chance to see what else we have here and enjoy your visit.

If there is time and if you have any questions, I would certainly try to answer them. Thank you very much for your attention and have a great conference. (Applause)

President Nordlund: Again, thank you, Commissioner Denn.

Mr. Lileikis: Good morning. My name is Joe Lileikis and I am with the B&B Association.

At this time, I would like to present and welcome Gordon Davids from the Federal Railroad Administration. Gordon graduated from Rensselaer Polytechnical Institute in 1963 and began his illustrious railroad career working for the New York Central, Delaware and Hudson and the Pittsburgh and Shawmut Railroads. Gordon started with the FRA as a regional track engineer in Philadelphia and then with the advent of bridgework worker safety regulations in 1992, Gordon just happened to get a job as the bridge engineer in the FRA office in safety.

Gordon is going to talk to us about the ever-popular bridge worker safety rules as well as mention a few things on railroad bridge integrity. With that, I give you Gordon Davids. (Applause)

FRA BRIDGE WORKER SAFETY REGULATIONS

Gordon Davids

Bridge Engineer
Federal Railroad Administration

Thank you Presidents Nordlund and Van Huis and distinguished guests. Thank you for the opportunity to get up here and talk with you about some of the points where you might have some contact with the FRA and our people.

Last year you heard from our administrator, Jolene Molitoris. She told you about the open-door policy at FRA, her expectations, and what your expectations should be. Jolene, as a speaker, is a hard act to follow. We have heard about the new FRA for decades, but this time we really have something.

We followed her lead into the negotiated rulemaking on roadway worker protection and came up with a notice of proposed rulemaking signed by all 25 members of the advisory committee. It still has to go through all the government hoops before it is published in the Federal Register as a proposed rule, but FRA people are ready to draw swords at a second's notice if anyone tries to mess with it before it comes out. Of course, there will be a period for public comment before the final rule is issued. We want it out in time so we can be ready for the 1996 production season.

The negotiated rulemaking process was a real thrill. It took a tremendous amount of work from everyone associated with the committee. There were moments of high drama, some sparking and arcing, and occasional bits of humor, but we knew pretty well from the start that the members of that committee were out to solve a problem and that they would succeed.

The solution is very workable. It will require some new thinking and acting by many people. It will definitely bring on a new level of awareness of the hazards of being struck by a train and of ways to eliminate the hazards. It will save lives.

One of the best examples of FRA partnering that is working right now is the bridge worker safety rule. It has brought about a whole new way of working on bridges. We know of some circumstances where railroaders have found themselves hanging from a harness rather than someone finding them lying on the ground under the bridge.

About half of my telephone calls are questions on bridge worker safety. It is encouraging to know that most of those questions are about the same few points in the rule, because it shows, first, that people are working the problems and, second, that the sticking points are not real show stoppers.

I can go over some of those questions right here and maybe we can discuss them a bit if we have time. I will be here through Thursday for AREA Committee 9, so if you don't catch me now, catch me later.

First, the objective of the rule is to eliminate hazards and save lives. We pointed this out to our inspectors that when they come upon a situation or a question, the first thing to think of is what is the hazard and what can be done to eliminate it. With this in mind, we have tried to apply the rule in the most practical manner and to avoid the appearance of nit-picking.

We know that no one is motivated to comply with FRA regulations only because he or she thinks that an FRA inspector might be sneaking up on the bridge. Likewise, no one is going to deliberately violate the regulations just because the FRA inspector is over in the next county inspecting a yard somewhere else. People are making it work because they understand how to do it and because they know that it is in their own best interest.

There is another government agency that has a regulation something like ours and they had a hard time getting it published. They deal with the construction industry which is a different culture than the railroads. Some of their people asked how we were able to get this rule out and working while they had problems. I told them that the railroaders don't have to prove anything to each other when they gather to work on a bridge. They have usually been working together for a while. They are highly motivated to return home safely at night and to make it to the next retirement party in one piece. Remember, it applies to trackmen, signal maintainers, as well as electricians just as much as it does to the bridge gang.

Enough philosophy. Here are some of the points that have been raising questions for the last year or so:

Working between rails. "This section shall not apply where employees are performing repairs or inspections of a minor nature that are completed by working exclusively between the outside rails, including but not limited to routine welding, spiking, anchoring, spot surfacing, and joint bolt replacement."

The Final Rule Notice in June of 1992 said that FRA would apply this exception strictly and that it is how we have to do it. The general rule is that the weight-bearing portion of the

body should remain inside the rails. There is no problem or hazard for someone to kneel inside the rail and reach outside to thread a nut onto a track bolt. There is a problem, though, if he reaches over the rail with a track wrench and starts to tighten that nut. If the wrench slips, he could go head over heels over the side. It is the same thing with driving spikes. Setting the spikes across the rail should not normally be a problem, but we do not want to encourage driving spikes across the rail on or off a bridge. The rails have to be there in order for someone to be between them. The place where a rail used to be is not a rail. The rule is clear, and we cannot tell you something else.

Prompt rescue: "The railroad or railroad contractor shall provide for prompt rescue of employees in the event of a fall."

You need a way to get someone to a place of safety if they fall. The rule doesn't go into any more detail than that. There are many good ways to effect a rescue if the rescuers are there, if they have a plan, if they have the equipment, and if they know how to use it. If anyone of those links is missing, there could be a serious problem in the event of a fall. Just calling 911 and hoping for the best is not a plan. If there is an arrangement in place and you know that the fire department can reach the bridge easily, they have the equipment and the knowledge to use it, and that it will work, you might stand a chance.

There has been some very innovative work in this area and it can only get better. My best advice is to work and listen to each other and pick the best solutions. Just don't ignore the problem hoping it will go away because that is just when you will find out if you can actually rescue someone.

We did not define "prompt," but you have to consider that there is always a chance of injury if someone falls off a bridge even into a harness. The harness itself is not too likely to cause it, but there is always the chance of hitting something while going over the edge. I have never jumped into a fall arrest harness and I have never felt a 900 pound load applied to my legs through a harness although I have hung from one for about a half hour (on purpose) and did not suffer. I was serving as a dummy while a group of Conrail bridge inspectors practiced rescues. They finally found something for which I was qualified. (Laughter)

There are situations in which a fall arrest system could serve as a restraint system to keep someone away from the edge of a bridge. The regulation does not have standards for restraint systems and it does not provide for restraints to substitute for a rescue plan. If this is a valid solution, we would need to evaluate it and go through the rulemaking process to get it into the rule.

Free-fall distance versus lanyard length: "The personal fall arrest system shall be arranged so that an employee cannot free fall more than six feet and cannot contact the ground or any lower horizontal surface off the bridge."

We sometimes find that someone equates a six-foot lanyard with a six-foot free fall. Such is not the case. It really depends on where the lanyard is attached. For instance, if a lanyard is attached to a rail and the deck ties are 12 feet to the edge, the free fall will exceed six feet. The simplest way to check it out is to connect the lanyard to the anchorage. Then measure the distance from the deck surface to the point of attachment of the wearer's harness at the center of the back and record it. Then drop the lanyard over the side of the deck (while the other end is still attached, of course, and while the person doing the measuring is tied off). Don't forget to include the acceleration device with the lanyard, even if you have to leave the harness attached to it. Measure the distance from the deck down to the point of attachment as it hangs. Add that to the distance above the deck you recorded earlier and that is the nominal free-fall distance.

The six-foot free-fall distance does not include the extension of the deceleration device, which could be as much as three feet six inches although it is usually less. The six-foot free fall also does not include the deflection of a lifeline once the slack in the lanyard is taken up. Of course, all these must be considered when you make sure that you will stop before you hit the ground or any lower surface.

So you see that lanyard selection is not always that simple and you might have to consider using different lengths for different locations. You also might consider retractable lanyards or split lanyards for more flexibility in some places. You also gain a real advantage whenever you can keep the attachment point above the level of the user, the higher the better as long as you can reach it to hook up.

Body belts versus full-body harnesses: "Personal fall arrest system means a system used to arrest the fall of an employee from a working level. It consists of an anchorage, connectors, body harness or body belt, lanyard, deceleration device, lifeline, or combination of these."

The regulation permits the use of a body belt in a fall arrest system. Don't do that. Use a full body harness. One thing we have learned since the regulation was published was that you do not want to hang from a body belt for more than about a minute even without having suffered the stress of a fall arrest.

Regional assessment: This year Region Four in Chicago conducted a region-wide assessment of bridge worker safety throughout the region. We got a pretty good handle on conditions, problems, and solutions all over the region. Some of the items I just discussed came from that assessment. I think most of the railroads that were contacted also gained some benefits.

These assessments are not witch hunts. They are a way of focussing our people and yours on the subject and trying to gain some improved understanding on everyone's part of ways to reduce hazards associated with working on bridges. We will try to do some more of these with other regions from time to time. It is not a good idea to do this with three or four regions all on the same railroad at the same time for obvious reasons. We will try to coordinate the efforts to be consistent across the country.

You might remember last year's conference when we promised to issue the FRA policy statement on railroad bridges. It was printed in the Federal Register in April and includes a finding that detailed regulations governing railroad bridge inspection or conditions neither required nor appropriate. It does include a set of guidelines that we consider basic to effective bridge management. They are not regulations and they are not mandatory. So far, no one has told us that they are off base either.

It is important that each railroad bridge owner should know the condition of its bridges and can protect against bridge related accidents. As long as everyone does that and if FRA can continue to make a record that you are doing that, we can defend this policy. However, if any railroad, regardless of size, makes the headlines with a bridge failure that results in casualties, all bets are off. FRA will be forced into a different position and that could well include regulations of some form.

We will be running some more basic bridge training for our track inspectors and we hope to have all of them trained by the end of next year. This is a good two-week course, but it does not make them bridge experts. Even with that, though, some of them have had the opportunity to do exceptionally well in dealing with bridge issues that have come up. The experience and knowledge they have gained while working with you and your inspectors has been invaluable.

We plan to pick up where we left off in 1993 with bridge assessment eventually reaching all smaller railroads. We will also maintain contact with all of the larger roads as well for several reasons. First, we have to maintain a current record to either justify or modify our policy of non-regulation.

Second, while we are doing that, the FRA inspectors are picking up valuable information and experience that they can use to solve problems that might come up later in different places.

Third, it has been very useful to have the track inspectors familiar with how railroad bridges work and the terminology that we use while they make their regular track inspections.

Every once in a while, they will see a bridge condition that concerns them and the better they are at understanding and reporting to you about those, the quicker you can get after the problems. It also rubs off on your roadmasters and track inspectors and they are the people who actually see the bridges most frequently, except for the train crews.

Again, thank you all again for the chance to talk about bridges and safety and the FRA.

Mr. Davis: Thank you, Gordon. My name is Bob Davis and I am with the Southern Pacific Railroad. I am the Roadmasters' standing subject chairman this year. Our first committee report is going to be in safety material handling. The chairman is Mr. Carroll Martin from CSX Transportation and the co-chairman is Larry White from CSX Transportation. Larry is going to do the report.

Larry White started out as a contract employee in the communications department headquartered in Youngstown, Ohio, over 21 years ago. He went into the quality control department and then assisted in the design and building of the geometry test car vehicle and track geometry car for CSX Transportation in Jacksonville, Florida. He is currently assistant roadmaster working in Livonia, Michigan.

He attended STES Technical School in Niles, Ohio, majoring in communication electronics technology and University of Richmond in Richmond, Virginia, majoring in business administration.

Would you please welcome Larry White. (Applause)

COMMITTEE REPORT

SAFETY IN MATERIAL HANDLING

Larry White

Assistant Roadmaster
CSX Transportation

Good morning. I would like to thank president Keith Nordlund, his officers, and the directors of the Roadmasters and Maintenance of Way Association for the opportunity and privilege of speaking today. This committee report is on the safe handling of materials and will be the last report before we break for lunch.

As professional men and women in the railroad industry, we know that there are many hazards involved in handling of materials. We also know that many injuries and even deaths have occurred when handling the many varied types of railroad materials. The paramount concern of each and every one of us should be the safety of our fellow co-workers and friends; taking the steps necessary to insure that every employee finishes his or her day working safely must be done. It is my firm belief that all accidents can be reduced and all injuries can be prevented.

Our key focus today will be the safest method of handling ballast, crossties, switch ties, bridge ties, and rail. We will reminisce about the good old days and share some information on the state of the art equipment now available.

Prior to beginning any job or task, we must do a proper job briefing. The survey suggests that there are six basic steps to a job briefing which are as follows:

1. Break down the job or tasks into basic steps and discuss their sequence with each person. Make sure everyone knows what is to be done first, second, third, and so on.
2. Identify all potential hazards that are related to the job or task, soliciting everyone's

input. Having everyone look for and point out possible trip and fall location, holes, or any other hazards gets everyone involved. Ask "what if?"

3. Check all equipment and tools for their condition and not use those found to be defective. Do this before using, even if the tools and equipment are thought to be in good condition.
4. Talk about what personal protective equipment is required for this job or task. Are back supports or respirators required? How about face shields or leg protection?
5. Make sure that every person understands the instruction. Only by communicating and asking questions can you be sure of clear understanding.
6. Follow up as the job or task progresses or as conditions change. Teammates could change as could the work location. Even the weather can change from sunshine to sleet to snow in a very short period of time.

These steps should be incorporated into the various jobs we perform daily. They are not limited to the heavier, more intense jobs, but also apply to the smaller jobs as well.

Meetings, both large and small, should not be excluded from job briefings. In addition to using tasks or job briefings, we must enforce strict rules compliance and safe job procedures to help reduce or eliminate injuries.

Most of us have probably heard Paul Harvey say that "the good old days weren't all that good." Even though there may be some of us in this room who are memory challenged, we probably will never forget the old way of unloading ballast. With come-alongs and chains, battling the stuck doors, clinging to the cars, handling the drag ties, while trying to control the ballast flow, keep your balance, and see through all that dust. After the cars were unloaded and spotted, each and every door had to be closed and locked. With side dump cars, it was extremely hard to close the doors on short notice. The automatic ballast cars of today have certainly made this job safer, cleaner, and less tiring.

A very good report on automatic ballast cars was given in 1993 by Carter Jones from the Union Pacific. Since that time, with the persistence and innovation of CSXT chief engineer Jerry Epting, a new remote controlled ballasting system has been developed.

Automatic ballast cars such as the ones from DIFCO have resulted in the maintenance crews and section gangs jumping at the chance to use the radio controls. The opportunity to control the amount of ballast at the needed locations while staying clear of the dust is very appealing. Being able to avoid slip and fall hazards, while doing the quality job are other strong points of the automatic ballast cars.

The main advantage of the automatic ballast car remote controlled system is that the ballasting operation can be directed by a person for one side unloading or two persons for both sides unloading anywhere on site with a clear view of the car. The operators of the transmitters can change positions to stay away from dust and debris during active ballasting. The flexibility gained for the operators with this system will increase the safety and efficiency of ballasting activities over a wide variety of terrain and track conditions.

A quality job briefing when unloading these automatic ballast cars should include the protective equipment of hardhat, glasses with side shields, and proper respirators. Check the hand held transmitters to see if this equipment is working properly. The ballast exit doors of these cars can close in three to five seconds, remotely controlled from up to 300 feet away. Every person involved must be warned of this potential hazard and told to keep clear of these doors during the unloading operation.

While unloading ballast in double track territory make sure that everyone understands whether the adjacent track is protected from trains by the dispatcher or is a "live" track where train traffic could come at any time in either direction. Ballasting operations should cease while trains are passing.

In the sequence of this task, establish the predetermined change-out locations such as road crossings in order to rest personnel and reduce fatigue. Remember to follow up if condi-

tions such as weather or terrain change.

The individual systems of an automatic ballast car combine compressed air, hydraulics, and electrical inputs from the remote transmitter to direct the movement of the doors.

An auxiliary air line runs from one end to the other of the car. On both ends of the car are air hoses with "glad hands" linking the automated ballast cars together and connecting them all to the locomotive main reservoir. Do not connect the auxiliary air line to the train air brake line. Connect only to the locomotive main reservoir. The auxiliary air line provides air to the system starting at the filter/regulator, and a lubricator that controls the inlet air to the air over the hydraulic pump and the air motor on the electrical system.

With the hydraulic system, the air cycles the pumps which pressurizes hydraulic oil from a five-gallon reservoir to the solenoid-operated flow control valves. The control valve assembly is a bank of eight control valves located at the center of each car. Each valve controls a cylinder mounted to one of the ballast gate doors. The cylinder is extended to open the door and retract to close it.

Between the lubricator and hydraulic pump, the air line splits, with part of the air going to the pump and the rest going to the electrical unit. The electrical unit consists of an alternator, air motor, and a 12-volt battery. If the air pressure in the line is above 35 psi, the radio decoder is linked to the 12-volt battery power supply, but remains in the stand-by mode. When a transmitter signal is received, the decoder goes into "ready" mode for ten minutes or until a new signal initializes the timer again. In "ready" mode, a decoder relay opens a solenoid valve in the air line allowing flow to the air motor which recharges the system.

There is one receiver/decoder per car. This receiver/decoder operates in the 450-470 MHZ ban with approximately 1,000 preprogrammed identification codes and will not allow a transmitter from one railroad to work on another. This eliminates the possibility of a ballast door opening or closing by stray signals from a "foreign" transmitter. There are two remote controlled transmitters per train. Each transmitter weighs approximately two pounds.

One car in a typical 50 car train is the train control car and is marked with a vertical black stripe at the center of both sides. This car carries the remote control transmitters in a storage box located in the center of the car. On the upper face of each transmitter are three rotary switches. Set the dials of these rotary switches to the last three digits of the car you intend to unload. If two transmitters are operating at the same time, set the channel switch to different channels to avoid crosstalk. Turn on the transmitter power by selecting power setting "inside on" to operate the inside or gauge side doors or "outside on" for the outside or field side doors.

The gates on the car are marked with either A, B, C, or D. Press the corresponding transmitter door switch toward "open" to open the selected door. When the door switch is released, the door will not close but stays in its position at the time of the release. When the hopper is empty, close the door by moving the appropriate door switch toward "close."

When ballast unloading is concluded, make sure all doors are closed. Turn off "power" to transmitters and return to the transmitters storage box in the train control car.

Some automatic ballast car manufacturers are using solar panels mounted on top the cars for charging the batteries of the receiver/decoder and the remote control transmitter. Other innovations could include adding cameras to each car. This would enable an operator to unload automatic ballast cars from the engine of the train, keeping him or her from the weather, the dust and the slip, trip and fall hazards.

In the operation of an automatic ballast train, dedicated power and regularly assigned crews should result in better turn around times from quarry to unloading site and back to quarry. CSXT currently owns over 600 of these cars and uses them in the 50-car unit trains The handling of crossties in the unloading process has changed since the good old days. In the not so distant past, we have unloaded gondolas of ties with four men inside throwing ties out, we have used cattle cars and cattle cars with kickers. More recently, we have used Burro

Cranes and backhoes to unload gondolas of ties. As you already know, this is labor intensive work with a great potential for injury. There had to be a better way.

In 1993, then vice president engineering Tom Schmidt and now senior vice president engineering and mechanical Carl Taylor assigned a team to create a Super Tie Gon for CSXT. Using 100-ton gons that could hold approximately 840 ties per car was needed. HBO gons were modified by the mechanical department's car shop in Erwin, Tennessee. These 100-ton gons were completely rebuilt. The sides were raised to 48 inches and the cars were painted orange.

Various options for a safer way to handle the ties from these Super Tie Gons were discussed. Existing tie handlers such as JIMBOs and LUCKYs had height limitations when transversing between cars, vertical height limitations, and center of gravity problems. After much input, the team decided on an excavator crawler because of the versatility, cost, and several other factors.

The biggest problem that was faced with an excavator crawler concerned the width of the machine that had the lifting capacity and reach to do the job. The unit had to be able to work within the confines of a nine foot six inch wide gondola. The action excavators that were eventually decided upon and purchased were standard CAT 320N crawlers. These machines are being used predominantly in Europe and Asia and only recently became available in the United States. What makes the CAT 320N somewhat unique is that it is a heavy-capacity machine with an out-to-out track width of only eight feet two inches while other excavators of the 320N's lifting capacity have out-to-out track widths of nine feet and wider. This narrow track width allows the machine to work inside a gondola which is approximately nine feet six inches wide.

The CAT 320N has a 128 horsepower, turbocharged engine and travels at a speed of 3.4 miles per hour. This machine has an approximate weight of 45,000 pounds, can reach nearly 35 feet and dig at a depth of almost 25 feet. The grapple opens to just over seven feet.

An equipment transport car for the CAT 320N had to be designed and constructed. This "mother" car had to be versatile, functional, and simple. A car with a ramp not bolted down and guides to help align the unit when it was set in place was needed.

The excavator could then maneuver in and out of the car and change ends for transporting. A box or "camp" was also designed for the grapple to be housed when the excavator was ready to transport.

When the CAT 320N is secured in the "mother" car, it can travel in road service at line speed. Of course these cars cannot be humped.

Using a CAT 320N, a tie unloader operator can unload a car of 840 ties in an hour if the density is in the 800 ties per mile range. If tie counts are in the 1,000 ties per mile range, the time needed to unload a full car is forty to forty-five minutes. The CAT 320N crawls across the ties as it unloads and crawls from car to car for a continuous operation.

Another issue that pertains to safety as well as being an environmental nightmare is the disposal of scrap ties. What might have been the common practice of storing ties on the property is no longer acceptable.

When ties are stockpiled on the right-of-way, it often attracts other dumping and increases the cost of clean up. Landfills and other environmentally safe dump sites for scrap ties are becoming rare and hard to find. At the present time, I would guess that CSX has approximately ten million used ties on the property and presently generate another two million annually.

To combat this problem, CSXT, along with Howdy Emery of Emery Tree Service have set up a chipping operation in Brewton, Alabama. They handle all our scrap ties.

Spent ties removed by our system gangs are stockpiled or loaded by contractors. About one-half are sold by the contractors as landscape ties and the rest are sent to Brewton in gondolas.

When the ties arrive, they are shredded and run over a magnetized conveyor where the

wood and metal are separated. As the wood comes off the conveyor, it is fed into trucks and delivered to Container Corporation of America, where it is used as a good high grade fiber fuel. This is a positive environmental solution and creates a win-win situation.

Concrete ties and the P811S are not new to most of us in this room. But I could not bring myself to ignore a machine that handles wooden ties, concrete ties, old rail, new rail, and ballast, all at this same time. This P811S uses a flow type system to prepare the surface for the new concrete ties. With so much support from ahead and at the rear of the P811S, a quality job briefing is vital for the safety of the each employee.

When handling rail from trains, communication with every employee is very important. All must acknowledge their understanding when forward or reverse moves are to be made and must position themselves so as to avoid injury. Without confirmation from each employee that the moves to be made are understood, no moves shall be made.

As we have re-engineered our work force, we have also looked for opportunities to eliminate injuries by finding better ways to accomplish our work and reduce the exposure of our employees.

Some of these changes were brought about because of the project by CSXT chief engineer, Jerry Epting. With Mr. Epting's foresight and input, small section gangs began using hydraulically operated tools for driving spikes, cutting rail, tamping track and tightening or removing bolts. Section gangs refer to these tools as back-saver tools. Matweld, Inc. of Paducah, Kentucky, has a power unit that is designed to deliver two, five gallons per minute or one, ten gallons per minute circuit to operate a variety of maintenance-of-way tools. This unit uses an 18 HP Briggs and Stratton gasoline engine with an electric 12-volt starter. Working pressure of the hydraulic fluid is 2,000 psi. This power unit weighs approximately 300 pounds. Two hydraulic tools that operate at five gallons per minute can be used simultaneously with this power unit.

With the impact wrench operating at five gallons per minute, crossing, frog and track bolts can be installed or removed in seconds. A stand-up handle is a definite back saver. This impact wrench weighs 26 pounds and has six sockets as accessories.

A small dependable and efficient maintenance tool that operates under many different conditions is the rail drill. It operates at five gallons per minute and has a simple clamp and height adjustment for quick setup for a variety of rail track configurations. The drill has a quick set indexing bar that provides accurate hole spacing. This rail drill weighs 63 pounds and uses standard flat spade bits that can be changed in 12 seconds without wrenches.

This rail saw is an abrasive saw that uses a 14 or 16-inch diameter blade. A sturdy pivot arm securely clamps to the rail and guides the saw during the cutting operation. Free axis movement of the saw allows cutting on either side of the rail, and clean separations average under two minutes. The saw weighs 29 pounds and operates at ten gallons per minute. The clamp weighs 21 pounds. Driving spikes into the toughest ties can be done in seconds, without redrilling with a hydraulic spike driver. Operating at ten gallons a minute, this spike driver has shock-mounted handles and weighs 74 pounds.

This spike puller weighs 38 pounds and generates 13,000 pounds of pulling force. It operates at five or ten gallons per minute. The jaws can be changed without special tools in minutes and has a hair-pin puller kit accessory.

When using hydraulic tools, remember that an oil injection hazard exists. Oil injection is a condition where hydraulic oil is injected under the skin from the pressure in the linings. Always wear all required protection equipment, including oil injection resistant gloves, when working with this equipment. Never carry a tool by the hoses. Repair all leaks and immediately replace any damaged hoses, fittings or other components showing wire braid, nicks, cuts, damage or abrasions.

For years, few section gangs would consider going to a job without mechanical jacks on their trucks. These jacks are used to surface and line track as well as

handling diamonds, frogs, and crossings. Mechanical jacks are safe, when used correctly, but if the jack was accidentally released with the jack lever bar in the socket, serious injury to the jack operator could result. Back injuries are also associated with mechanical jacks because of the physical force needed to raise the jack.

The first hydraulic jack was built by Matweld, Inc. at the direction of CSXT chief engineer, Jerry Epting, and was demonstrated at an AREA meeting in Chicago in 1992.

This hydraulic jack was designed and built by Simplex in 1992. Weighing in at about 50 pounds, this jack was designed to allow one-person operation with low lever bar force and no kickback from the lever bar when released. Hydraulic jacks can lift and lower in precise, controlled increments with nine-inch throw and comes with a swing away handle for carrying and positioning. These features have made the hydraulic track jack a big improvement in helping to reduce back injuries.

With companies and entrepreneurs struggling for a piece of the safety pie, many new products are becoming available. One such tool is the weld de-molder from ESCO. This device is designed to safely remove field weld molds after pouring, prior to shearing weld upset. It also eliminates potential personal injuries from burns associated with mold removal when using a ballast fork and sledge hammer. This tool, which weighs approximately 12 pounds, makes mold removal a one-person operation and encapsulates the hot mold material for safe transfer.

Another product from ESCO is a tie caddy that uses six gripping teeth over an eight-inch bearing area. This device should help reduce injuries by providing a more stable movement of crossties and switch ties as compared to two point clamping devices that allow the tie to swing and possibly cause someone to be injured.

A jumbo tie caddy is available from ESCO for placing and removing double plank crossing timbers and can double as a bridge timber handler. This caddy weighs approximately 30 pounds.

To safely handle insulated joints without causing damage to the joints, an insulated joint sling has been developed with a rated capacity of 4,000 pounds. The padded jaws keep the insulated joint from sliding in the sling.

In conclusion, we all know that everything we do in engineering is safety related. By using some of the new and innovative types of equipment available, most jobs will be less labor intensive. This should reduce the possibility of injuries while handling materials. Having our employees return home to their families in the same condition as when they came to work is a worthy and necessary goal. The equipment described in this report should also result in quality engineering work from a cost-effective manner.

Thank you for your attention. (Applause)

President Nordlund: Larry White and Carroll Martin, thank you very much for the effort that you put in and for the job briefing at the start of your presentation.

MONDAY AFTERNOON SESSION

PRESIDENT'S ADDRESS

John Van Huis
Chief Engineer, Structures & Production
Wisconsin Central Transportation Company

Good afternoon and welcome to the opening session of the 100th B&B conference. At this time, the registration figures are as follows: B&B 83, Roadmasters 137, guests 73, and suppliers 244, for a total of 537. There are also 88 spouses registered.

At this time I am supposed to give the president's address. I rather it was labeled president's remarks as I am not one much for public speaking so please bear with me. It took seven years to get to this point and in about five minutes I am done.

I am certainly humbled and honored this past year being president of the Association. There have been quite a few highlights over the past about which you have read in the newsletter, but I want to bring to the forefront again today certainly for the Proceedings and for the record a couple of those items. One of which I am most proud of in the seven or eight years that it took to get to this point for myself and quite a few others, are continuing seminars and the success those seminars have provided the Association. Like I said, I guess it started close to six years ago with the first seminar and we are proceeding with future seminars. Secondly, one of the outcroppings of the seminars has been the scholarship program. For those of you who have children who are eligible, we urge you next year to partake in the offering of the scholarships. It is our way of paying back all of our members. It will be somewhat interesting several years from now when hopefully one of our scholarship recipients might be standing up here as nervous as I am.

The third item that I want to discuss is our membership and what it takes to make the Association move on. Our membership has continued to grow. However, it is not easy growing when you watch what is happening in our business with the buyouts, early retirements, and mergers. It makes for a particular challenge for the board and for the officers of the association and also the members to continue to find new members. We can't sit idly by and see that just happen by itself. For any of you out there who know of people who could

certainly be a member of this Association, we urge you to bring them to our attention. We are always actively pursuing new membership.

At this time also I would like to thank you and, for the record, thank the roadmasters board who, without the spirit of cooperation that we have had in the last five to six years, we probably wouldn't be as successful with our joint conferences as we are in the last three to four years. I think that has been pretty rewarding. They are our counterparts and they are our friends in this deal. They are not an entirely different group; but we are a joint concurrent group.

Finally, I give thanks to REMSA and all the support they give our associations.

On a little bit of a more somber note, for the record I would like to read a letter I received in the last few weeks from Mr. Bill Nelson. Bill was director of our education committee and quite frankly spearheaded our efforts in the seminars over the last three years. It says,

> *"Dear Mr. Van Huis: It is with much regret I must tender my resignation for the position of chairman of the education committee. My health continues to deteriorate which will restrict my activities. The Association must have a person who will be able to travel as well as organize the seminars. It has been a very rewarding experience to have worked with the professionals concerned with railroad bridge construction and maintenance from various parts of the country. My hope is that the seminars will continue to be attractive to the type of audience we have had in the past. Attendees have come from many areas such as railroad engineering departments, railroad construction departments, colleges and universities, consulting firms, United States Army and Navy, and railroad supply companies. The largest task facing the new chairman will be that of organizing the railroad bridge repair seminar.*
>
> *Sincerely, William H. Nelson."*

For those of you who don't know Bill, he did put a lot of time and effort into it and I thought it only fitting that we recognize him here during my remarks.

I have some special thanks at this point to past president Don Steele. He's a pretty tough act to follow. I hope he was as nervous as I in this position. He seems to call the office every week asking how things are going or if people are following up and it takes an awfully long time to get to where you are and a very short time to get out of it. He set a pretty tough table to follow and I hope I did.

There are a couple other past presidents who have been pretty important to me including John Horney and Jerry Iwinski. They both seemed to push me into this place that I am right now. When I first started out with the Chicago & Northwestern, John and Jerry both got after me and said I needed to get involved. They said it would pay off some day. I am not certain what that means, as I'm nervous as can be. I don't know if that's what I really wanted to have happen.

I also want to thank the office staff, Pat and Barbara. It took seven years, but I think I recognize their voices over the phone now. I always thought there was only one, but we paid for two. My thanks to them certainly for the phone calls to the home office for status reports and writing my newsletters. Unfortunately, they refused to do this writing for me.

Lastly, they can't be here, but I want to thank my family, my wife Suzanne and my two sons, Alex and Adam. When you have kids in second grade and kindergarten, it's pretty hard for the spouse and family to take part in the activities. However, she partakes I guess by making sure things stay quiet on the home front when it takes time to do things like this.

That is it for my remarks. At this time, I would like to turn the program over to chairman Joe Lileikis. Thank you. (Applause)

Mr. Lileikis: Unfortunately I can't just ad lib and make a five-minute remark and sit down because I have to do the rest of the program. (Laughter) It seems like anymore we railroaders have to maintain a great deal of flexibility in our day-to-day lives. As a result, we are going to have a program change.

Continuing on now, our next presentation this afternoon is "Track Geometry for Bridgeworkers." The presenter is Jim Pinkerton with Union Pacific Railroad.

Jim comes to us as a past employee with Missouri Pacific Railroad where he has held various positions as a trackman, track operator, assistant foreman, and track foreman. Anything that there is to do with track, I think Jim has done it. He is also very familiar with the State of Illinois, having lived in various locations like Chester, Salem, and Mount Vernon. He has lived in Melbourne, Arkansas, and spent a little time in Memphis, Tennessee. He is currently working as a manager of track maintenance in Chester, Illinois. With that, please welcome Jim Pinkerton. (Applause)

TRACK GEOMETRY FOR BRIDGE WORKERS

Jim Pinkerton

Manager Track Maintenance
Union Pacific

The information I will be covering this afternoon will be dealing primarily with FRA track safety standards. Each road could have standards of their own that could be more stringent than the FRA would be. They could be found in the form of the Book of Standards, Rule Books, Chief Engineers Instruction for Standards, Operating Instructions and Special Instructions.

Track geometry can also be defined as track elements. Railroad track is composed of straight or tangent segments with curves connecting those tangents. The rails are spaced a uniform gauged distance apart. Maintaining gauge, surface, and line are primary track maintenance functions. The Federal Railroad Administration, or the FRA, sets prescribed requirements for track geometry commonly known as Track and Safety Standards. Each portion of track has a maximum operating speed and that speed will determine the class of track. Each class of track will have different parameters and requirements.

It is Rule 213.9 out of the FRA book that gives you the different classes of track and what your maximum operating speeds would be for freight and passenger trains. To find the speed of a track, refer to the subdivision page of the current timetable. The maximum subdivision speed for the Chester Subdivision would be 60 miles an hour. Then on the opposite page is a secondary mainline and its maximum operating speed is 35 miles an hour. From there, you determine your class of track.

Gauge is measured between the heads of the rails at right angles to the rails in a plane of five-eighths of an inch below the top of the rail. FRA Rule Book 213.53 gives you your different gauge measurements. Your maximum for Class track I would be 4 feet 10 inches. Then notice the gauge must be at least 4 feet 8 inches. Nothing is allowed under 4 feet 8 inches on any class track for gauge.

The alignment can run from one-half inch to five inches out of line on tangent track and

three-eighths of an inch to five inches out of line on curves measured at mid offset or mid ordinate from the 62 foot line or chords. That should indicate the rail and your mid ordinate of 31 feet with a 62 foot chord. You measure from the rail to the chord to try to get your degree of curve.

You can see on the track on the left. On the hi-rail there would be the 62 feet string up against the rail for the gauge side of the hi-rail. That knot is a 31 foot mid ordinate and that is where you would measure the gauge side of the rail to the string. It is showing just to be a little over a 3-degree curve.

On tangents, the ends of the line must be at points on the gauge side of the line rail five-eighths of an inch below the top of the rail. Either rail may be used as a line rail.

On curves, the ends of the lines must be on points on the gauge side with the outer rail five-eighths of an inch below the top of the rail head. Good alignment on a bridge contributes to overall quality ride and also reduces stress and maintenance and makes a good target for the track department to line into. Curve elevation is the height of the outer rail above the low rail. Elevation can run from zero to six inches. Each road could have different maximum design superelevations. On the Union Pacific, it is five inches.

Once you find out what your degree of curve is, you can find your maximum operating speed. For example, on a 4-degree curve, go over to, say, 3 inches and you will find that 46 miles per hour would be your maximum operating speed for this curve.

The degree of curve and elevation together will determine the speed of your track. The degree of curve and elevation can be determined in a number of ways.

In the profile book, about an inch or so up from the bottom of the page, there is one straight line that says, "alignment and flange lubricators." That also shows curve degree and superelevations for that particular curve. It has the mile post also. That is one good way of finding out what the degree of curve is and the maximum elevation.

Another way is to use a curve chart which gives you a little more detail. It actually gives you the track. It gives you the curve number, usually the milepost, and whether it's a left or right-hand curve. It also gives you the degree of the curve, total spiral length and your super-elevation designed for that curve.

Spiral is a gradual change in the degree of curvature and elevation from zero elevation to full elevation. Runoff is the gradual reduction from full raise to the existing track.

The FRA book also gives you different parameters for runoff on tangents, curves, the body of your curve, and the spiral. There is a paragraph that would primarily deal with warp.

The affects of improper elevation on surface of gauge is as follows: Wide gauge results in rough riding trains because as greater nosing action or truck hunting action increases, there is lateral stresses and bending when the gauge is regular. Rail head wear will also be irregular. Wide gauge is likely to initiate poor line of surface. Wide gauge may result from several causes. Unfortunately, carelessness of the workmen in using the track gauge is a common cause of this problem. Close supervision and instructions are necessary to maintain a snug fit on the track gauge and to have the rail and the tie plate both firmly and squarely seated.

In gauging track, one rail is taken as the gauge rail and the other rail is gauged to it. When gauging track in curves, the hi-rail should be the gauge rail and the low rail gauged to it. Wide gauge is likely to occur at those locations where decayed ties do not provide sufficient holding power for the spikes. In extreme cases where several bad ties are together, spread track and derailments may occur.

On a middle tie plate, you can see a little plate movement to the outside. When measuring track, you need to take into consideration that the track needs to be measured as it would be under load. In that particular instance, the gauge there would have to be 57 inches. You would probably add another quarter of an inch to that to make the gauge out to 57.25 inches.

The affects of poor alignment are rough riding, excessive and irregular rail wear, serious contribution to poor surface. The track crews are capable of removing local irregularities and

line by eye. Most such lining is, however, of questionable quality. Swings and false tangents are introduced into the straight track and dog legs or hooks may occur in the curves. Therefore, most roads use automatic tampers and liners to ensure correct alignments on bridges. It is important to understand that all geometry measurements including surface apply to the track in its loaded rather than unloaded position. Many a track that shows perfect cross level on gauge when unloaded is anything but level under traffic. Any weakness in the support system subgrade, subballast, ballast, drainage, and ties will affect the track surface.

Rough track is a potential cause of derailments. Excessively low or battered joints being alternately spaced on opposite rails may start a car or locomotive rocking until one or more wheels are rocked off the track. A low spot in one rail followed by a low spot in the next rail or two heads on the opposite side may have the same effect. This effect is normally referred to as twist or warp.

Each of these three defects, gauge, line, and surface, become more severe as speed increases. The primary function of ballast is to retain the track laterally, longitudinally, and vertically under dynamic loads imposed by railroad rolling equipment and thermal stress is exerted by the rail or sun kinks. Ballast also provides adequate drainage for the track. Good clean ballast is important to good drainage both on the track and on ballast deck bridges. The ballast also is a primary substance for maintaining a proper track surface.

Each crosstie should be made of material in which rail can be securely fastened. Each 39-foot section of track should have a sufficient number of crossties which in combination provides support that will hold gauge, maintain surface, and maintain alignment within the limits prescribed.

Each 39-foot segment of track shall have the following non-defective crossties: In Class Track I, it would be 5, in Class II and III tracks, it would be 8, in Class IV and V, it would be 12. Now, on most roads, 12 defective ties in a 39-foot segment of track would be 50 percent. These ties should not be broken through, split, or otherwise impaired to the extent the crosstie will allow the ballast to work through or will not hold spikes or rail fasteners, so deteriorated that the tie plate or base of rail can move laterally more than one-half inch relative to the tie, or cut by the tie plate through more than 40 percent of the tie thickness.

Class I and II tracks shall have one crosstie whose center line is within 24 inches of the rail joint location. Classes III through VI shall have one crosstie whose center line is within 18 inches of the rail joint.

The FRA book also gives you the parameters for or requirements for joint ties. Any mismatch of rails at joint may not be more than that prescribed in a table set by the FRA. That is rule 213.115 out of the FRA book.

Looking at a joint with a gauge mismatch, the rail on the right looks like the flange of the wheel has been catching that rail. That could cause the wheel to climb that rail and result in a derailment.

That is a shot of the same joint from the top view. Each rail joint must be of the proper design and dimension of the rail joints for the rail to which it is applied. If a joint bar on Class III through VI is cracked, broken, or because of wear allows vertical movement on either rail when all bolts are tight, it must be replaced or slow ordered to the Class I or II speeds.

If a joint bar is cracked or broken between the middle two bolt holes, it must be replaced. Center cracked joint bars are not good for any class of track.

In the case of conventional jointed track, each rail must be bolted with at least two bolts at each joint in Classes II through VI, with at least one bolt in Class I track. When they are talking about each rail, that means each rail end must have at least two bolts in it and not just two bolts and a joint, but in each rail end. When dealing with the 36-inch angle bars for the six hole angle bars, even though there is one bolt out of that one rail end, we still have two in that end and three in the other. The two in that end still makes it good for Class II through VI. No rail or angle bar having a torch cut or burn hole may be used in Classes III through VI.

In Classes III through VI track where timber crossties are used, there must be tie plates under the running rails on at least eight of any consecutive ties. Each 39 feet segment of rail shall have a sufficient number of fastenings which will effectively maintain gauge within the prescribed limits. The rail fastening would be your spikers or Pandrol clips and so on.

Another consideration that bridge workers could possibly take in is track buckling. Track buckling prevention is a program developed as a way of preventing track buckles or sun kinks. Track buckling prevention deals with blanket slow orders, and slow orders on account of track work, whether it be production work or maintenance work. It also deals with removing or adding a rail and track inspection requirements during high ambient temperatures.

A level board is one of the tools of the trade. It is commonly used and has a number of different functions on it. It has a level bubble, and it also actually shows you which way the track tilted. It will actually show you the low side or the high side of your curve or which side is out of cross level with your cross level readings on it. It also has a gauge reading on it for track inspectors who are dealing with guard face check.

It is always handy to have a tape such as a 62-foot string with magnets on each end. One person can actually go out and clamp that on the rail and do the measuring. The last item I would like to comment on would be the first thing we consider before starting any job and that is safety. Safety is the most important element in performing our duties. Obeying the rules is essential to job safety. Job briefing is a very important part of our safety processes on the Union Pacific. Safety, quality, and productivity are the results of a well-planned and properly conducted job briefing.

Employees must be careful to prevent injuring themselves or others. Employees must check the conditions of equipment and tools and must not use any tool or equipment that has been found to be defective. In case of doubt and uncertainty, take the safest course. Track equipment, bridge equipment, locomotives, railroad cars, bridges, and track can all be replaced, but the one thing that we cannot replace is a human life. Remember that. Safety is my responsibility. Thank you. (Applause)

Mr. Lileikis: Thank you. Before you walk away, we are giving cups to people who give presentations. We appreciate your work. Thank you very much.

BRIDGE DECK CONVERSION IN 110 MPH TRAFFIC

J. A. Lileikis

Senior Engineer Structures
Amtrak

We had a cancellation last week so what I would like to do is take a few minutes and talk about a bridge replacement project on Amtrak that we completed approximately two months ago. It is really nothing outstanding or different than what a lot of other people have done with respect to deck conversion projects or taking it from open deck to ballast to deck. What really made this project complicated was the fact that we had trains running by us at 110 miles an hour all the time from about 5:00 o'clock in the morning to 11:00 o'clock at night. The interval was about every 15 or 20 minutes on adjacent tracks so the work window opportunities were not that great.

The scope of the project was to remove the existing rail and bridge ties on the deck girder span. We had eight, 80-foot deck girder expansions that were removed in order for to us lower the concrete piers and the abutments to new elevations so that we could maintain the same type of rail profile throughout the area.

One of the things you have at Amtrak is an overhead catenary wire that is very important to the operation of the trains. It is all electrified territory and we have to keep things in one location. We also had to install a lot of polymer leveling pads and new precast concrete brick pedestals. Then we had to go back in and reinstall the deck girder bearings, the spans themselves, do the rubber on top of the steel, and then the deck spans. You will see in a little while why we had to pour polymer between the joints at the slabs. Then we had to do water proofing, foot walk and handrail installation, and then open the thing up after we put the new ballast, ties, and rail back in.

Some of the parameters that we had to work within is we had to maintain 110 mile an hour traffic on the two adjacent tracks. We definitely had to minimize traffic delays to the passengers. If you slow down a freight train, the freight doesn't belly-ache too much, but when you get thousands of people sitting on a track wondering if they are going to be late for their appointments or late for work, they have a tendency to get rather irate.

Again, we had to maintain the existing profile. We had to lower the concrete abutments about five feet. Some of the other things that we had to do within the parameters of this project was contend with the Maryland Department of Fish and Wildlife. It was during the spawning season of the river so we had to be very quiet working around the fish. We also had to worry about the Corps of Engineers and, of course, Gordon's FRA people. We also had to comply with Amtrak's Track Safety Standards which encompasses just about everything.

An additional challenge that we had to overcome was the weight of each span was approximately 40 tons. The environmentalists did not allow us to travel through the waterway so as not to disrupt the spawning fish. As a result, the work had to be done on adjacent tracks for the most part. Obviously then you have to have hi-rail equipment, which we didn't have, so we had to rent it.

Since we were working from the adjacent tracks and in order to keep them open during the period of high usage, we were only allowed to take one track out of service from 11:00 o'clock at night to 5:00 o'clock in the morning. We definitely had to be clear off the rail at 5:00 o'clock because at 5:05 a metroliner out of Washington was coming through the area at about 110 miles on hour.

Once we got started on this, the work went around the clock. We had work crews from

two different locations, Prairieville, Maryland, and Baltimore, Maryland. The project site itself was south of Baltimore. We had to coordinate two shifts for four different crafts throughout the entire project. That included track, B&B, signal, and electric traction in addition to the transportation department and their people.

Mother nature was a tremendous asset for us throughout the course of the project also. It was late June and early July when the project was done. We had temperatures in the 90 plus degree range during the daytime with a relative humidity of roughly 70 percent except for the days when it was 100 percent. That was almost every day because we had some pretty torrential downpours and thunderstorms throughout the area.

This is a view of the structure as we are looking towards Washington. Track one is this track and track two and three are adjacent to it and had been converted at some point in the past. Our project was to work entirely on track one and try to make it look just like the track next to it, except newer.

This is a view from the underside showing the existing stone piers and built-up concrete pedestals on top of the old piers. We started one evening with rail and bridge tie removal. It was done at night. We started stripping the rail off. We could not cut the rail; we had to drag it all the way off. Rail at Amtrak is a very hot commodity and there is not very much of it around to scrap and use over so it had to be treated very gingerly and be taken care of. The tie removal took place as we were going across the bridge pulling ties off one at a time because that is all the equipment could handle. By morning, we finally had the thing stripped off. That day we had two cranes from Cranemasters out of West Virginia visit us and they set up their operations to help with the girder removal. We had planned on taking evenings from about 11:00 o'clock to about 5:00 o'clock in the morning for girder removal. The 11:00 o'clock window depended upon when the last train went through that area. Normally that was one that was not historically on time. The 11:00 o'clock time was sometimes 1:15 in the morning and sometimes 12:45. Regardless of whatever time it showed up, we still had to be clear at 5:00 o'clock in the morning.

The girder removal was one where we picked the girders up with two hi-rail-mounted cranes, one on each end, and set it on a set of trucks in between the two cranes. Then we pulled it back off of the site, off the location, and out of the way. We then picked it up again, and set it off to the side on blocking which was on top of the rail.

Now the initial intent on this project was to set it on flat cars. We didn't really want to move the flat cars. We just wanted to set them up on the flat cars just to keep them out of the way. Our car inspectors refused to let us put them on the flat cars because the wood on the flat cars was pretty pathetic. Even if we put the old ties underneath it, they still refused. We actually had one car inspector looking at some brand new oak ties and rejecting to put them on because it had some check marks on it. He would ask us, "What are these holes on the side of this thing? Why is that there? Why are these lines across this tie for the penetration?" This guy actually came up with his little finger and put it in the spike hole to find out if it was rotten inside. Needless to say, we scrapped that part of the plan.

After the girders were removed, we went ahead and started in on our concrete demolition phase. This was actually supposed to take about six days to do the whole thing with the magnitude of concrete that was coming out. As it turned out, we found that these concrete pedestals on top of the stone piers were not anchored into the stone pier at all. So when we started coming in there and tearing these out, we found that they came off very quickly which really helped us out tremendously. The six days that we had scheduled for removal of concrete actually only took a couple. The biggest chores actually were to retrofit the abutments and back walls in order to accept the new slabs. Again, that work was done 24 hours a day because we were really not affecting the operation of traffic at that point.

Safety netting was used wherever we had the operation with girder removal, tie removal, or whatever working over the track or over the waterway. We had safety nets strung out underneath it. Then we did the concrete removal.

As you can see here, the ground is rather wet looking which was pretty characteristic of the entire project. After we had everything removed including all the concrete blocks, we went ahead and started with our tie pad installation by virtue of putting in leveling pads of polymer. Then the back walls had to be addressed in order to accept the precast concrete slabs that went over the back wall. They came back in about five or six feet so we had to level all that out and get that all taken care of and continue on from there.

Once that was done, we could go ahead and put our concrete pedestals back in to get the spans at the proper elevation. This was a surveying nightmare. The first evening we started putting these in we found out as we were going across the bridge at about the forth or fifth pier that we were about three inches out too far to the right as we were looking at it. However, we were following the surveyor's mark. We had them come out the next day and they verified that my suspicions were correct, we were too far to the right. It would have been fun trying to make that match on the north end.

When the pedestal was in place for the most part, we did a little preparatory work. We came back in and had to put the bearing blocks back into the thing so that we could get our slabs back in. That was a pretty simple operation. Once we had the pedestal blocks in the right locations putting the clearing pads in was a really easy chore.

Re-installing the deck girders meant bringing Cranemasters back out. We had planned at this time to only use them for two evenings. First of all, we had three days scheduled for the girder removal and it only took a night and a half so that worked out really nicely. When we went to put the spans back in, we conveniently picked the evening of July 3rd to start. Amtrak runs a completely different schedule on the holidays. The 5:05 a.m. train that normally comes through that area is not one that runs on a holiday. Consequently we had to almost 9:00 o'clock in the morning to work on span replacement.

As you can see the nets were back in place because we were going to be working along sides. We didn't want to have to worry about the guys having full fall protection on them. Therefore, we had the safety nets to catch them. We went ahead and put our outrigger supports back in which were retrofitted once the contractor knew what the height was from the pier to the span so that he could set these things down and put the outrigger down for the cranes. They went back out and picked up all of the spans that they had set hundreds of yards north of the bridge. They just basically reversed the operation and brought it back out to the site, picked it up, and started to set it back into place.

Keep in mind during all this time the catenary wire over the top was not removed. The power was cut off so we wouldn't fry ourselves, but it still was an obstacle overhead with the cranes.

With the first span back in place, we found out that, yes, it did fit. Seeing that this one fit we knew that we probably had a pretty good chance of everything else fitting and we commenced moving all of the outrigger supports down with our little "one tie at a time" crane while the contractor with his rail equipment was going out and picking up the spans.

The intent behind that was we would have everything set up when they brought the span out. We were actually able to pick up the span and set it down trying to minimize the time between intervals. By about 6:00 o'clock in the morning, we had two or three spans left to sit. By the time the transportation department was saying, "We need you to get off the track, please," we were setting the last span. I informed them that we were down to the last span and asked where the train was. They said, "It's very close. We need you to get off the track in the next 15 minutes." I looked at the contractor and said, "Can you get this thing set in 15 minutes?" He said, "Maybe."

Well, he actually put it down in about three or four minutes and we got off the track and cleared. Everybody was cleaning up and looking at each other as the train went by, so we were out of the way.

We started a slab operation and went ahead and put all the rubber down on top of the

flanges of the deck girder, brought out the slabs on a work train and started picking them up. We had planned on putting in the slabs in about three nights worth of work but we were able to do this in about a night and a half also.

Here is a picture of the guys picking up the slabs off the flat car and putting them in place. You can see the trough in between one slab and the adjacent one. This trough is designed so that we can go ahead and put some reinforcing bars in there and tie them together. We can fill that void with polymer which precluded Amtrak from putting any kind of hook bolts to fasten the slab to the top flange of the steel.

Here's a view of the all the slabs in place. You can see that we had put the handrail brackets on the slab as we were going so that we wouldn't have to hang off the edge to put the handrail brackets back on. After that was over with, we went ahead and did a little bit of cleaning work and started tying all the rebar together. They brought a kind of ready mix out there and we started filling up all the voids with polymer.

Keep in mind that even while the men were standing out there, the safety net was still underneath us. The next phase was to put the handrail and the foot walks back in place so that when the track department came through there we didn't have to worry about their fall protection needs.

In the waterproofing stage you can see all the voids between the two are now all covered up with polymer. The foot walk and handrail is installed and the waterproofing was done in one evening into the morning. It was a pretty standard waterproofing scheme.

Here is the finished product. Again, to reiterate some of the things that were done, we removed and replaced eight 80-foot 40-pound girders. We had to demolish about 52 cubic yards of concrete and we had to then in turn install 18 one and a half cubic yards of concrete pedestals. We had 72 ten-ton concrete deck slabs that had to be placed and it took about 60 cubic yards of polymer to fill all those voids.

We had expended approximately 15,500 manhours to complete the project. There was a total labor cost of almost a million dollars and the material cost was about half a million dollars.

When you look at it and see the effective cost of $2,344 per linear foot, that is not great, but it is really not that bad when you take into account that all of your transportation charges and everything like that is also thrown in there.

Some of the accomplishments that we got "atta boys" for were that delays to passenger traffic were tremendously less than anticipated by both Amtrak and the Maryland Area Rapid Transit type people. The transportation department, who was probably our biggest skeptic and said that we couldn't do it in the timeframe that we were supposed to do it in, thought what we did was great. It was done pretty much within the anticipated budget. We figured we would probably end up spending about $1.5 million to do the job and that is what it came in at.

The nicest thing was we really didn't have many injuries. One worker pulled a muscle in his arm on the very last day while putting a catenary wire back together. That was the only thing that was really sustained. The added benefit to this whole project was approximately two or three hours after we had placed the track back into service, we had a catenary failure. In other words, we lost power to run trains on tracks two and three. However, we had just put track one back into service. If we had not had track one back in service, we would have had a stretch of railroad where we could not have run any trains whatsoever. That would have really made a lot of people mad. We kind of lucked out in that respect a little bit.

Again, here's a shot of the final project. Thank you. (Applause). Our next presentation is problems encountered in remodeling existing buildings.

COMMITTEE REPORT

PROBLEMS ENCOUNTERED IN REMODELING EXISTING BUILDINGS

David Oram

Engineer Contracts
CSX Transportation

Our objective is to create a comprehensive check list depicting the process of identifying and dealing with all of the influencing factors which must be considered in order to ensure successful planning and execution of construction which is within or part of an existing railroad structure.

Project Delivery is the Mission: No railroad is in business to provide building facilities, but the railroad building facilities are necessary instruments to provide transportation services. The facilities are as necessary as the locomotives, rolling stock, track, bridges, and train control systems and each has a specific role in providing the service. As professional B&B officials, our charge is to deliver the "right" product safely, with quality and cost effectiveness. Many details must be identified, considered, balanced, organized, synthesized, combined, manipulated, coordinated, juggled, and molded in order to ensure successful completion. Omit or mishandle any one of the many details and the project can quickly become unsuccessful, if not a disaster. Become entangled in the multitude of details and the focus on the objective of the project can be clouded. The professional clearly understands the objective and coordinates all the details to delivery of the project.

Project Delivery is the Mission: A comprehensive checklist is provided in this report. The checklist could well have been presented as a flow chart depicting an interconnected process. However, a checklist was chosen to provide a tool which can be used to guide the efforts of a B&B supervisor charged with remodeling or modifying an existing building.

All steps in the checklist may not be appropriate in all types of projects or at all sites. In less complicated projects, steps may be combined.

To compliment the checklist, a commentary is provided to further elaborate on details associated with each section. Use of the checklist and commentary, along with the skills of the B&B professional will aid in project delivery.

Following is the commentary that would accompany the checklist:

1. Customer requirements and restrictions: Customers (who many times in the case of remodeling projects are internal customers to a B&B supervisor) must be involved in the process of remodeling existing buildings. The reasons why the project is required and the role of the project in supplying transportation services is known best by the customer. Failure to involve the customer can lead to the total failure of a project; i.e. a project which does not serve the intended business function.

1.1 Define project objective: Customers vary from those very knowledgeable to those completely uneducated in the building trades and processes necessary to deliver a particular project. As a B&B professional, the task is to work with the customer regardless of familiarity level, define the objective of the project and lead the effort to make the concept a reality.

Project objectives should not be confused with scopes of work to achieve a given objective. For example, a defined objective for a project may be to provide a specific transportation officer a quality private office in which to conduct specific business activities, while the scope of work may include painting, HVAC work, flooring, and all the particulars necessary

to achieve the objective. Or the scope could be to relocate the officer into an alternative existing facility which meets the objective.

Failure to identify the objective can result in a cost effective solution being overlooked. Alternates such as rationalizing building in an area to reduce expenses can be viable methods to meet objectives and reduce costs. The key is to have customer involvement with all parties involved dedicated to realizing the project objective in a safe, quality, and cost-effective manner.

1.2 Determine desired completion date: This is a self-explanatory check list item. Omit this item, fail to have a clear understanding of the customer expectation and/or business reason to deliver the project by a particular date, or incur premium costs for no useful business purpose when a date is not critical and the project delivery process results become less than can be obtained.

1.3 Determine budget restriction: If the customer or sponsor has budget restrictions, clear the air early. Planning for a project which will not be funded or will be restricted to a maximum level wastes time and money.

1.4 Identify funding source: Projects require funding! No matter how well intentioned the customer, no funding kills a project quickly. Involving all parties in the funding question can aid in frugal spending and cut wasted efforts.

1.5 Determine customer restrictions during construction: Polling the customer concerning work hours available for construction or relocation is permissible during construction can affect planning, construction means and methods, costs, and schedule.

2. Survey existing conditions: This section includes the steps to determine and record the existing conditions. Accurate and complete surveys eliminate omissions in planning which result in surprises leading to such undesirables as exceeding estimated costs and project duration.

2.1 Record physical dimensions and conditions: The details are important. Taking the time to get complete information the first time is an investment which pays dividends by saving time repeating survey trips and making changes due to incomplete planning.

2.2 Obtain pictures and/or video of site: This step is especially valuable if others become involved in the planning process. Pictures document the "before" conditions.

2.3 Determine current ADA compliance in building: This step involves not only looking at the area to be remodeled but also the entire facility, including the parking area, building egress areas, signage, door knobs, and rest room facilities. Many municipalities require ADA upgrades in connection with building permits issued for a project.

2.4 Record location and condition of:

2.4.1 Electrical system
2.4.2 Lighting fixtures
2.4.3 HVAC system
2.4.4 Supply and waste water systems
2.4.5 Communication systems
2.4.6 Computer terminal connections
2.4.7 Building structure
2.4.8 Roofing system

This survey section requires not only the documentation of the conditions in the area to be remodeled, but also examining the systems with respect to the entire building.

2.5 Determine presence of:
2.5.1 Lead paint
2.5.2 Asbestos
2.5.3 Radon
2.5.4 Petroleum-based waste materials
2.5.5 Other hazardous substances
2.5.6 Excessive noise emissions

Environmental concerns can affect construction costs and duration as well as performance of the facility after project completion. Legislation is extensive and changing. With the multitude of facilities projects on any railroad, project specific areas could be any combination of the following: air emissions management, hazardous materials management, hazardous waste management, natural resources management, petroleum, oil, and lubricant management, solid waste management, special pollutants management (asbestos, PCBs, radon, noise) and water discharge management.

3. Customer relations: This section of the checklist is devoted to follow up with customers. Maintaining communication with the customer keeps the customer informed and involved with the project. Changes during a project are a reality. Keeping a customer informed minimized the adverse affect of changes whether the changes are requested by the customer or due to a variety of unanticipated construction occurrences. Keeping a customer informed can also permit taking advantage of the project which is ahead of schedule.

3.1 Review with customer prior construction: On a relatively small project, the review can take place during the initial communication with a customer as the objective and scope of a project is developed. On a more complicated project, repetitions of individual steps may be required.

3.1.1 Conceptual plan: Review of the conceptual plan with the customer allows for input and changes from the customer before detailing a construction scheme. This review also develops the common clear understanding of the details of the project. Do not assume the customer understands a drawing or a verbal description of the plan. Communicate by both explaining the project and listening to comments made by the customer which show a thorough understanding.

3.1.2 Cost estimates: This review makes the customer aware of the estimated costs for the project. The project cost benefits can be reviewed prior to expending any funds.

3.1.3 Proposed schedule: Project delivery is built around time and money. This review is the companion to the estimated cost review. Acceleration effects should be reviewed from both a schedule and cost viewpoint.

3.1.4 Construction impacts on existing operation: Early notifications of the affects of construction on existing operations allow the customer to prepare for the temporary inconvenience of construction. Time available is used to minimize the inconveniences and/or arrange for alternate housing during construction.

3.1.5 Determine desires for customer periodic observations of work in progress: This is a relatively simple step in project delivery that very often is omitted. Making this determination can lead to joint observations that make the process more efficient by eliminating misunderstandings and time lag in communications.

3.1.6 Determine frequency of project process reporting: Specific projects and varying customers can determine how often project progress reporting should occur. Project progress reports should provide information concerning the schedule, expenses, activities, and critical issues requiring customer input.

3.2 Report during construction:

3.2.1 Schedule versus actual progress versus projected completion.

3.2.2 Budget versus to date spending versus projected final cost.
3.2.3 Changes in scope and/or conditions.
3.2.4 Receive change input or decisions from customer.

Reporting during construction (project progress reporting) should cover four basic areas:

1. Schedule including restating the original completion date, progress to date (i.e. is project on, behind or ahead of schedule?), a current projected completion date based on the latest information available, and a summary of critical events occurring in the reporting period.
2. Costs including restating the original estimated cost, the spending to date, and a current projection of the costs at project completion.
3. Changes listed which have occurred due to customer requested changes and/or due to construction events.
4. Upcoming customer decisions required should be relayed to aid the customer in keeping current with expected customer decisions. Customers vary and may well not realize a decision to be made by them is unanswered.

Checklist for the Remodeling of Existing Building:

Frequency: Reports should be provided at intervals determined in frequency of reporting (see 3.1.6)

3.3 Post-construction feedback: Each project can be used to improve the next. Customer feedback as well as feedback from all involved with the project provides the basis for those improvements.

3.3.1 Final walk through with customer: Self explanatory follow up to determine customer satisfaction. This opportunity allows for questioning the customer as to how the facility is to be used and gain knowledge for the next project.

3.3.2 Determine if objective obtained: This step determines the successfulness of the project. Fail to determine this and it may later be found that "the alligators were all killed but the object was to drain the pond."

4. Planning and definition of project scope: This section contains steps involved with the planning and defining project scope. Again, on a relatively small project the planning and scope definition may occur during the initial communication with a customer during a project walk through. On a more complicated project, repetition of some individual steps may be required.

4.1 Prepare conceptual plan: The word "plan" in construction generally is perceived to mean a drawing. In some remodeling projects, a drawing may well be in order and in other relative projects, a list of items to be accomplished may be sufficient.

4.2 Prepare conceptual cost estimate: Self explanatory step which is applicable in some form to all projects.

4.3 Review conceptual plan and cost estimate with customer: See comments sections 3.1.1 and 3.1.2.

4.4 Prepare final plan including:
- 4.4.1 Physical layout
- 4.4.2 ADA compliance measures
- 4.4.3 Electrical modifications
- 4.4.4 Lighting modifications
- 4.4.5 HVAC system modifications
- 4.4.6 Supply and waste water modifications
- 4.4.7 Communication systems modifications
- 4.4.8 Computer terminal connections modifications

The final plan, whether detailed with drawings and specifications or requiring only a list of items to be completed, should be detailed and complete so as to cover all of the work necessary to deliver the project. The list of work areas provided above includes the majority of areas to be considered during most remodeling projects.

4.5 Prepare an abatement plan for:
- 4.5.1 Lead paint
- 4.5.2 Asbestos
- 4.5.3 Radon
- 4.5.4 Petroleum based waste materials
- 4.5.5 Other hazardous substances
- 4.5.6 Excessive noise emissions

When environmental issues are identified, the appropriate plan to remedy the issue must be made. The B&B supervisor must recognize and follow up. Oftentimes this may require the assistance of trained environmental service companies.

4.6 Prepare final cost estimate: Self-explanatory step which is applicable in some form to all projects.

4.7 Review final plan and estimate: See comments sections 3.1.1 and 3.1.2.

4.8 Obtain customer plan approval: An often overlooked step which serves to continue to involve the customer, provide feedback, and may very well prevent waste in the project delivery process.

5. Construction execution: Planning is complete. This section is the actual construction process and is the test for the quality of the planning. Changes occur during construction and the professional B&B supervisor must recognize and handle the changes as they occur.

5.1 Company force:

- 5.1.1 Order materials: A self-explanatory step. The details are especially important in this area. Delays can easily occur if sufficient lead time is not provided or insufficient or incorrect materials are ordered.
- 5.1.2 Schedule forces: This step is to coordinate the availability of the labor force. A reoccurring problem can be the late finishing of preceding project or the diversion to an "emergency" which results in a project delay.
- 5.1.3 Communicate and instruct forces: Communicate the plan including sharing the project objective. Personnel cannot perform unless the goals and tasks are clearly understood. Communication includes both talking and listening.
- 5.1.4 Obtain permitting: A self-explanatory step.
- 5.1.5 Provide special construction equipment required: Since most company forces have basic tools required to do the work commonly performed, this step is to provide any special equipment required to perform the work or perform the work more cost effectively.
- 5.1.6 Perform regular periodic observations of work in progress: This is a follow-up step. Wait until the project is complete and the opportunity to correct any area during construction is lost. Undesirable time and money effects are usually involved with failing to observe during construction.
- 5.1.7 Perform final inspection: Performing this step and including those who actually performed the work not only insures the details of the work have been carried out as planned but also serves to improve the work force.

5.2 Contract Work

- 5.2.1 Prepare bid documents: In simple terms, bid documents communicate to the bidder what the bidder is to provide and discusses the return compensation arrangements. Bid documents can vary from a complete set of drawings, specifications, sample contracts, instructions to bidders, and proposal forms to a relatively simple list of items a contractor is to include in his proposal. Varying from the very simple to formal should be set to be appropriate to the specific project. Bid documents are vital in establishing the clear understanding between the contractor and owner.

5.2.2 Pre-qualify prospective bidders: This step is to determine if the prospective bidders have the abilities and wherewithal to perform the work desired. To avoid contractor difficulties, know who you are dealing with.

5.2.3 Conduct pre-bid meetings: A pre-bid meeting or site inspection insures all bidders receive the same information and provides the opportunity for bidders to examine the work site. The information provided at pre-bid meetings also becomes a part of the clear understanding between the contractor and owner. Care must be taken to not contradict the bid documents or not share the same information with all bidders.

5.2.4 Receive/tabulate bids: Self explanatory. Determine if the proposal meets the funding limits.

5.2.5 Review proposed schedule: Self explanatory. Determine if the proposed schedule meets the required schedule.

5.2.6 Prepare and execute contract: Self explanatory. Should undesirable events occur, the ramifications of not having the proper contract in place can be costly.

5.2.7 Review insurance: Normally insurance is required as a condition of a contract. However, the certificate of insurance provided by a contractor shows evidence of the actual insurance being in place. As with a proper contract, should undesirable events occur, the ramifications of not having the proper insurance in place can be costly.

5.2.8 Handle labor relations issues: Self explanatory. This item varies from property to property. Omit a required step and a delay or extra cost may be incurred.

5.2.9 Issue notice to proceed: This starts the contract time running.

5.2.10 Perform regular periodic observations of work in progress: This is a follow-up step. Wait until the project is complete and the opportunity to correct any area during construction is lost. Undesirable time and money effects are usually involved.

5.2.11 Perform final inspection: This step insures the details of the project as planned and that the contractor's contractual responsibilities have been met. This step should occur prior to final contractor payment.

5.2.12 Perform final contract close out prior to final payment: Review all the punch list items for completion and insure any items required by the contract are completed prior to final payment.

5.3 Project review: This section includes the areas of follow up necessary to complete the project, receive feedback to improve future projects and insure customer satisfaction.

5.3.1 Assemble record drawings (as built): Self explanatory. Pictures or a video may also serve to aid in future work.

5.3.2 Review environmental compliance: This follow-up step is to review whether any waste items were left by the construction force (i.e., paint cans, barrels, petroleum products), required records have been assembled, and to review performance concerning any abatement plans.

5.3.3 Review final cost: Compare final cost with the estimated cost to improve and refine future estimating. Review impacts caused by any changes during construction.

5.3.4 Review final completion date: Compare final completion date with the original scheduled completion date to improve and refine future scheduling. Review impacts caused by any changes during construction.

5.3.5 Review customer satisfaction issues: Follow up may have identified items of customer concern. These concerns may require action on the project or may serve to improve future projects.

Conclusion:

Project delivery includes the management of time and money to achieve a given business objective. Focus on the objectives, plan, involve the customer, execute and follow up. These steps will deliver projects which will be predictable, controllable, consistent, and ever improving.

Project delivery is the mission! Thank you.

Mr. Lileikis: Next on the agenda is Preston Sargent with Union Pacific. Preston is going to give a presentation on growing trees in the desert.

Sarge gave me a nice little biography and I read it. Now, I have known Sarge for a long time and he is really not giving himself a lot of credit in his biography. Sarge started with Union Pacific in 1969 when he was hired on as a bean counter clerk. Obviously, he didn't really see a lot of future in that area, so he took it upon himself to start going to night school. As a result, Sarge earned a Bachelor of Science in construction engineering from the University of Nebraska. In 1979, he joined the structural design group in the mechanical area and has been pretty much in the mechanical discipline with Union Pacific ever since.

He is currently manager of special projects mechanical and he says here that his outside interests include Boy Scouts, soccer, and the Republican party on the local level. Now, I know Sarge is avid with Boy Scouts and goes camping all the time. I have played soccer with him so I know he is an avid soccer player. Please welcome Sarge. (Applause)

GROWING TREES IN THE DESERT

Preston Sargent

Manager Special Projects-Mechanical
Union Pacific

After watching Joe's presentation, I am a little bit bashful about doing this because compared with the scope of the work he just did, putting water to the trees in the desert doesn't amount to a heck of a lot. However, I would like to thank Joe for that kind introduction anyway. I would also like to thank the board for having me here and for you people sitting here listening to me.

Supposedly I was to give a very short presentation about growing trees in the desert. Specifically we are talking about along the Union Pacific track in the area called Devil's Playground in the Mojave Desert. That is on milepost 205 to 236. Some of you might wonder why the railroad would be spending its time and money on growing trees in the desert especially doing something that Mother Nature didn't feel it was worth her time to do. But, of course, we all know that sanity and railroading are not necessarily used in the same speech.

The answer to that is very simple. The reasons are derailment and labor productivity. The sand has a tendency to pack underneath the rail plates and work the spikes loose. I have been told that prior to our instituting growing these trees, we were averaging about one derailment a week due to losing the gauge on the track.

As you can see from this picture, the sand did have a tendency to get deep when it got out of control. There is a power line or signal line there, I believe. I would like to say that we knew all the answers going into this thing when we were approached about this, but the truth is we spent 30 years learning how to do what we eventually ended up doing.

So let me start off by giving you a little background on our efforts to grow trees in the desert. The actual concept of using trees was derived by a sister company of ours, the Southern Pacific, back in the 1950s.

This gives you an idea of what it was like back then. They instituted their program and these trees are about five years along. Sand dunes would be built up and with the wind blowing out there they have a tendency to move across the landscape. The trees take care of that. They help us quite a bit.

These trees are called the tamarisk or salt cedars. They originally come from the middle east. To get them started, we just lop a branch off and we stick them in the ground and give them a little water and get them growing. It is amazing that they can do that. We currently have about 60 miles of trees. That is 30 miles on each side of our mainline. That amounts to about 40,000 trees. Each tree needs about 20 gallons of water per day or 800,000 gallons during the hot weather. It takes about two gallons per tree during the winter. As we get further on, I will assure you they do have winter in the desert.

It was found that the ideal dimensions for protecting our trackage is a tree of about 20 feet high and 18 feet across. This will cause the sand to fall outside of our protected tracks and give the foliage density to keep the sand from blowing through.

These next pictures show how we maintain the trees. This is the way we used to do it in the old days, but we have a little better way of doing that now. We used an automated cutter that not only tops out the trees, but maintains the drip line for us also. This was a lot easier on the people when we started doing it this way.

Let's talk a little about the problems we encountered in our efforts to grow and maintain these trees. It was a very interesting project in a number of ways. The problems can be broken down into four categories; that is, local environment, getting the water out of the ground, getting the water from the ground to the trees, and getting the water into the trees. The local environment includes the soil, the weather, and the animal life. We found the soil highly corrosive and attacks both steel pipe and our aluminum pipe. It wasn't very biased in that way.

The sun and the temperature had a tendency to degenerate the PVC piping that we tried and the local rattle snakes just love the heck out of our shade. Most of our people weren't too happy about working at the base of the trees because they always found these critters back in there.

Another problem that we had with the local animals is they were attracted by the water that we were putting out for the trees. This created quite a few problems for us. Getting the water out of the ground also had its obstacles. The depth from the grade to the pump level ranged from 165 feet at the low point to 652 feet at the high point and which, I believe, was up at Kelso.

There is no electrical. We had a high percentage of fines in the water supply and with this depth our well pump rates varied from 145 gallons a minute to 1,000 gallons a minute. The pumps were designed to be engine driven because we had no power. Because they were diesel engine driven, we had drive shafts as long as that well was so we had anywhere from 145 to 652 foot drive shafts. Talk about a maintenance problem! Whenever you had to pull that well, you had a gentleman out there pulling it out section by section by section. We had lifting derricks over the top of each one of those wells.

Of course, that happened a lot because of the high fine particles we had in the water. It abraded the pump heads. So we were pulling those every couple of years.

We did have the capacity to water the trees. The trouble was our high capacity wells were at the bottom of the hill and it was 1,560 from the top to the bottom and, of course, that equates to about 674 pounds of pressure differential between the top and the bottom of the hill.

To try and adjust for the wide range and pumping rates that we had available, we tried a few things. We tried some open pits with a liner in them. We also tried some big Baggies. It was kind of a rip off from what the United States government did for fuel storage and water storage for the troops. We tried several of those to even out our flow rates because of the needs of the trees.

Of course, the last category is getting water into the trees. Now, it shouldn't have been a problem, but it was probably our most difficult area. The primary means that we originally used was ditching.

We had a row of ditches and the trees were looking a little sparse. Because of the steep grades and the distance involved, that's why we had to have these lines running parallel with the take-offs going to the ditches. Otherwise the water would run down hill in extremely fast rate and we couldn't get an even distribution. So we had to do those taps. That meant our people had to go out there and manually open and close those values going down that hill at intervals and water the trees heavily and just keep that up.

Anyway, they were doing a lot of that. Of course that was not what we wanted them to do. We wanted them to be out there trimming trees and actually planting some more. We also tried using a drip-type system such as was developed in the Middle East and a pipe system with holes drilled in it at intervals. The drip system is a loop and a hose buried in the ground. Unfortunately, our local animals also discovered that they could dig these things up, chew them up, and they had a source of water for staying alive and they were destroying the system about as fast as we could replace it.

We also tried a plastic pipe with a hole drilled in it. We drilled the hole in the plastic pipe, laid it out there, and just pumped water into it and let it squirt out. That's when we found out about another little problem. When we quit pumping water into that, there would be a little bit of an air gap formed in the top of the pipe and spores would get in there and algae would grow. Then what would happen is that the next time we would turn on the water in the pipe, the algae would plug the holes up. So every once in a while our people would have to go through and take that pipe apart and flush it out. It basically became just another maintenance problem.

It was amazing how all these things were coming about and it was getting extremely labor intensive. After a while, Joe's boss got tired of spending all his time out there maintaining a piece of pipe system that was actually in the way. Because of the tree cutting device we had to have, they had to be fairly close to the trees. So they moved that pipe over against the trunk to get it out of the way.

You might wonder why that tree looks so sickly. It's probably because at that time when this picture was taken, we had a freeze and it damaged the trees. We had to grow them back by feeding them some water.

It was in 1991 that Jerry Edwards got very upset with having to do this and he wanted to find a way that we could improve the way that we were doing these trees. He decided he needed a new system and he had some very definite criteria that he wanted. One was to reuse as much of the existing material as possible. It also needed to be automatic so his people didn't have to spend all day running up and down the tree line opening and closing values. He wanted the pipe to be buried and a sprinkler mechanism that was out of the way when the trimmer was going to be operating. He wanted it to operate on a two-day cycle so that they could have one off day for doing their maintenance. He would also like to have all the systems interconnected so that if one system went down, a neighboring system could be used to take over that operation. He also wanted to figure out a way to reduce weld pump maintenance and he wanted to reduce the amount of water being used.

About that time Joe and Jerry gave me a call and we took a look at it. We looked at all the things that had not worked in the past and we had quite a history to draw on to tell us things that did not work or things that were giving us problems.

The first thing we did was contact the local conservationists office and the U.S. Forest Service to get some information about the trees and local soil conditions and things like that. What we found out is probably what most of you already knew: We had a silty sand with a large percentage of rock and gravel. The soil doesn't hold water very well at all. In fact, it drains very freely.

A tree gets 80 percent of its water in the top two feet of the soil. The root coverage is approximately equal 1.5 times the trees height. As the root structure goes deeper, of course, its abilities to gather water tapers off because the root structure also tapers off. So what we have here if we were providing a drip system or a sprinkler system with single spotted type thing. What was happening is we were watering one location and that water was going straight down. We were actually having very little exposure to the roots and they were having a difficult time getting the water.

One of the reasons it was a little better was because of the fact that we had a drainage ditch on each side of the tree and a wide range of area that we were flooding with water. The ditches were high maintenance and they did silt in. We had to open and close the valves all the time. They also had a tendency to just be in the wrong place at the wrong time when we were using the trimmer.

So now with these two pieces of information the Forest Services gave us, we designed criteria and this is where Joe came in. He got the unenviable task of putting in the system.

We installed a 200-pound PVC pipe system running parallel with the track on both sides. We also installed automatic timers. We broke up the 60 miles of trees into zones. These zones were the maximum capabilities we could handle in 24-hour period. We put automatic timers and controllers on them, installed electric submersible pumps in the wells and put in electric generators. Those generators not only drove the pumps, but they also drove the controlling mechanism for these things.

Now we had to overcome the pressure problem. We did definitely have a pressure problem. We had 600 and some pounds at the bottom of the hill that totally had ruptured that pipe and shattered all of our piping so we put in intermediate pressure control stations coming down the hill that would permit us to use the wells on the upside to help water the trees on the down side. By doing that, we greatly reduced one of the things that Jerry needed to do and that was reducing well maintenance.

As I understand it, it had a significant impact on that. I haven't heard of one of those wells going down since we put in the new pumps and they used to call me about every year, so that's not too bad. Basically they were one-half mile zones and we put them on the 24-hour cycle. They would open and close the valves automatically so our people didn't have to go out there.

We used a specific spray head which was a manned spray head developed in Israel. The nice thing about it is it can vary the droplet size, the angle, and the spray pattern that they use so it became very specific. They were able to set that to provide for the trees. We put them on 40-foot centers with an over 50 percent overlap.

Now, Joe was responsible for supervising the installation of this and he actually called me and told me that it worked. Any time that happens, I know it must be a success.

We have had over a 50 percent reduction in the water consumption. We even had a greater reduction in the amount of diesel fuel consumed running the pumps because for the most part, we have more efficient pumps. But we also only have to run them every other day where we used to run them 24 hours. We were on a rather long cycle there.

The trees are nice and green now and our people are spending all their time trimming trees and planting new ones.

With that, I thank you. (Applause)

Mr. Barrett: Our next presentation is a committee report called Fall Protection and Safety Climbing Devices for Bridge Inspection. The chairman of the committee is Steve Ross

from Conrail. Steve graduated from the University of Kentucky in Lexington with a Bachelor of Science degree in civil engineering in 1986. He immediately joined Conrail and worked in the track department. He served in various positions including design and construction engineering for two years and has been senior structural inspector for the last five years.

He is a registered professional engineer in the State of Pennsylvania. In his spare time, Steve is an avid rock climber. About three years ago, he began a program to implement climbing techniques into the Conrail bridge inspection program.

Please join me in welcoming Steve Ross. (Applause)

COMMITTEE REPORT

FALL PROTECTION AND SAFETY CLIMBING DEVICES FOR BRIDGE INSPECTION

Chairman: R.S. Ross, Sr. Structures Inspector, Conrail

Co-chairman: J.E. Evans, Brdg & Strs Constr Supv, CP Rail

Committee: M.A. Cyrus, B&B Supv., Willamette & Pacific
D.B. Clarke, Asst Dir Transp Center, U. of Tennessee
N. Desjardins, Norguard Industries
W. Gall, Sys. Stl. Br. Insp., Conrail
R. Guenette, Proj. Coord., Surety Mfg. & Testing
R.S. Lamb, B&B Foreman, Union Pacific
P.H. Porzillo, B&B Supvr., Norfolk Southern
P.M. Roddy, Sr. Strl. Insp., Conrail
R. Truitt, Exec. VP, Western Sling Company
A.S. Uppal, CN North America
S.M. Whitacre, Burgess & Niple, Ltd.

Thank you, Pat, and good afternoon ladies and gentlemen.

The bridge inspector is entrusted with great responsibility. He is responsible for the safety of the public as well as that of his fellow employees. His duties help ensure the protection of the environment and the safe keeping of some of his corporation's most valuable assets. In order to provide this protection, he must be able to perform his job quickly and efficiently and yet maintain a high level of quality. He must do all of this without neglecting his own safety. Even though he will often be working at dizzying heights, this does not mean he must place his life on the line, at least not in the conventional sense.

The average railway bridge inspector working in North America today inspects roughly 500 bridges a year, and some of these more than once a year. This statistic underscores the primary difference between the inspector and the bridge worker, a critical need for mobility. While the bridge worker will often be stationed in the same work location for months at a time, the inspector must be constantly moving from one bridge to the next. On the structure itself, the bridge worker frequently works within limited confines for prolonged periods. The inspector must access every square inch of that structure without lingering in any one location for too long. In recognizing this difference, it should be readily apparent that equipment and techniques used for access and protection will differ, too.

It was the mission of this committee to collect and present alternatives in fall protection for the safe, thorough, and efficient inspection of railway bridges. A survey was conducted of North American railroads requesting information on the types of fall protection in use and other pertinent information applicable to bridge inspection.

Unless you climb or belong to an emergency rescue squad that practices high angle res-

cue techniques, you will probably be unfamiliar with many of the terms used in this report. Rock climbing techniques have recently been adapted and put into use for bridge inspection on some railroads and also in some governmental agencies responsible for inspecting bridges. Canadian National, New Jersey Transit, and Conrail reported using climbing techniques in their bridge inspections. On the highway side, CalTrans has just issued a Code of Safe Practices for climbing techniques in bridge inspection. They recently applied these techniques in assisting the Army Corps of Engineers and the Bureau of Reclamation in an emergency inspection of a damaged floodgate where conventional means of access could not be used in the time frame required. The Army Corps of Engineers is currently in the process of working up their own policy.

Kentucky DOT has been using rock climbing techniques in bridge inspection for over five years and Ohio DOT has recently begun training its inspectors. The industry appears to be leaning in the direction of accepting climbing techniques as a viable option for bridge inspection.

Since many railroads are unfamiliar with these techniques, special emphasis has been placed on climbing in this report to introduce the techniques as an alternative to methods already in use.

FRA Policy and Regulations

49 CFR Part 213 – Policy on the Safety of Railroad Bridges: An interim statement of policy issued April 1995 established guidelines for railroads to use in bridge management. The guidelines are advisory, not regulatory in nature. Guidelines six through eleven address bridge inspection specially. In regard to inspection frequency, the policy states:

6(b) The prevailing practice throughout the railroad industry is to inspect railroad bridges at least annually. Inspections at more frequent intervals may be indicated by the nature of a structure or intensive traffic levels.

49 CFR Part 214 – Bridge Worker Safety Rules: This regulation issued in 1992 and revised in 1994 governs anyone working on a railway bridge. A height threshold of 12 feet was established at and above which fall protection becomes mandatory. Other detailed requirements for fall protection systems and equipment are detailed and can be referenced in the regulation. Although the original rule did not differentiate between classes of work, the revision dated June 14, 1994, gives the bridge inspector a great deal of latitude in the use of fall protection and reads as follows:

214.103(b)(2) This section shall not apply to employees engaged in inspection of railroad bridges conducted in full compliance with the following conditions:

(i) The railroad or railroad contractor has a written program in place that requires training in, adherence to, and use of safe procedures associated with climbing techniques and procedures to be used;

(ii) The employee to whom this exception applies has been trained and qualified according to that program to perform bridge inspections under the provisions of that program, and has accepted the designation;

(iii) The employee to whom this exception applies is familiar with the appropriate climbing techniques associated with all bridge structures the employee is responsible for inspecting;

(iv) The employee to whom this exception applies is engaged solely in moving on or about the bridge or observing, measuring, and recording the dimensions and condition of the bridge and its components; and

(v) The employee to whom this section applies is provided all equipment necessary to meet the needs of safety, including any specialized alternative systems required.

This revision is important in that it allows the inspector to use his experience and judgment in deciding when and when not to use fall protection. It also places a responsibility

Two Men Roped Climbing/Belaying

Conrail bridge inspectors Ken Kellerman (left) and John Zenz demonstrate protecting with a belay on the lower chord of this deck truss over a canal of the Delaware River in Easton, Pennsylvania.

Solo Climbing With Webbing

Conrail bridge inspector Ken Kellerman inspects a deck truss bridge high above Rondout Creek, a tributary of the Hudson River in upstate New York.

on the railroad to ensure that the inspector has the proper equipment, skills, knowledge, and training to properly protect himself and enable him to make sound decisions when selecting a technique or piece of equipment for a particular application.

Access and Fall Protection Alternatives

There are several alternatives available to the bridge inspector if he is properly equipped and trained. Some of these alternatives can be used in combination. All have their advantages and disadvantages. The following criteria has been developed for evaluating and comparing methods:

Safety: What level of fall protection does the method offer? Does the method prevent falls or arrest them? Are there opportunities for other injuries to occur such as strains and sprains? Is bulky equipment used which requires multiple setups? What level of fitness is required to perform techniques?

Thoroughness: Does the method allow the inspector to get within arm's length of the structural member being inspected? Is he able to inspect the entire bridge using this method? Will this method help the inspector meet his responsibility of inspecting all bridges on his territory?

Efficiency: How fast is the method? Does the method require track usage? Does the method require interruption of automobile or water traffic? Is extensive training required? How much does the method cost?

Keeping these criteria in mind, here is a breakdown and evaluation of some alternatives available:

Inspection vehicles: These include under bridge units, aerial lift units, and crane supported hanging baskets. The major advantage of these units is that they are occasionally the only reasonable means of access to particular areas of a structure. Also on the plus side, they don't require much from the inspector in terms of physical strength. There is a major downside however. The rail-mounted units require track usage. Because of increases in traffic volume on one hand and railroad downsizing on the other, it is becoming increasingly more difficult to compete with rail traffic for inspection time. The highway units also present difficulties requiring lane closures and highway traffic disruptions. These units are also very costly to purchase or rent. Most of the railroads surveyed only own one bridge unit which must be shared and used over large territories.

Scaffolding and staging: These access methods make for great work platforms but simply take too much time to set up, move, and tear down. They are well suited to the bridge worker but rarely fit the needs of the inspector.

Ladder: This is an indispensable tool. On small structures where there are few setups required, it is invaluable for accessing bearing areas and floor system connections. On larger structures, however, limited reach can become a problem and just lugging the thing from one setup to the next can introduce the potential for a back injury.

Nets: This method of fall arrest is very expensive and time consuming to set up and tear down. The erection of such systems is usually beyond the scope of work conducted by railway personnel and is handled by private contractors. This type of protection is normally used to protect workers on a large project that justifies the expense and is not well suited for use in bridge inspection.

A variation on this idea has been used to access floor system connections using the net as a platform and using an independent system to anchor the bridge inspector. This method has proven effective where access is difficult or impossible using other means.

Lifelines: Horizontal lifelines are currently in common use by bridge and track workers on bridges. They provide a continuous means of protection but often limit the user to the deck of the bridge. Vertical lifelines have been introduced that can be used in conjunction with horizontal lifelines and add another dimension to the inspector's range of movement. Factors that must be considered before electing to go with this type of fall protection are:

Ascending

A CALTRANS engineer/technician uses mechanical ascending devices to access pin connections on this deck truss highway bridge over the North Fork of the American River in California.

1. How does the system connect to the bridge?
2. What is the set up time required?
3. Can the inspector set it up or does a manufacturer's rep have to erect the system?
4. If the inspector can set it up, how much training is required?
5. Does the system foul the track?
6. Can the inspector remain connected to the system during train passage?
7. Is the system compatible with a wide range of structures?
8. What does the system cost?
9. Is training included in the cost of the system?

These questions will have to be answered by the manufacturer of the system. A system of this type could potentially be very useful on larger scale structures.

Rail rollers/sliders: Rail rollers and sliders are a common means of anchorage employed by bridge and track workers. They provide good mobility when used with welded rail but limit the inspector to track level. On jointed track, joint bars present obstacles that require either removing and replacing the roller/slider or connecting to another roller/slider on the other side of the joint. The sliders are generally much lighter than the rollers and slide surprisingly well on the rail. A major drawback with these devices is that they do foul the track.

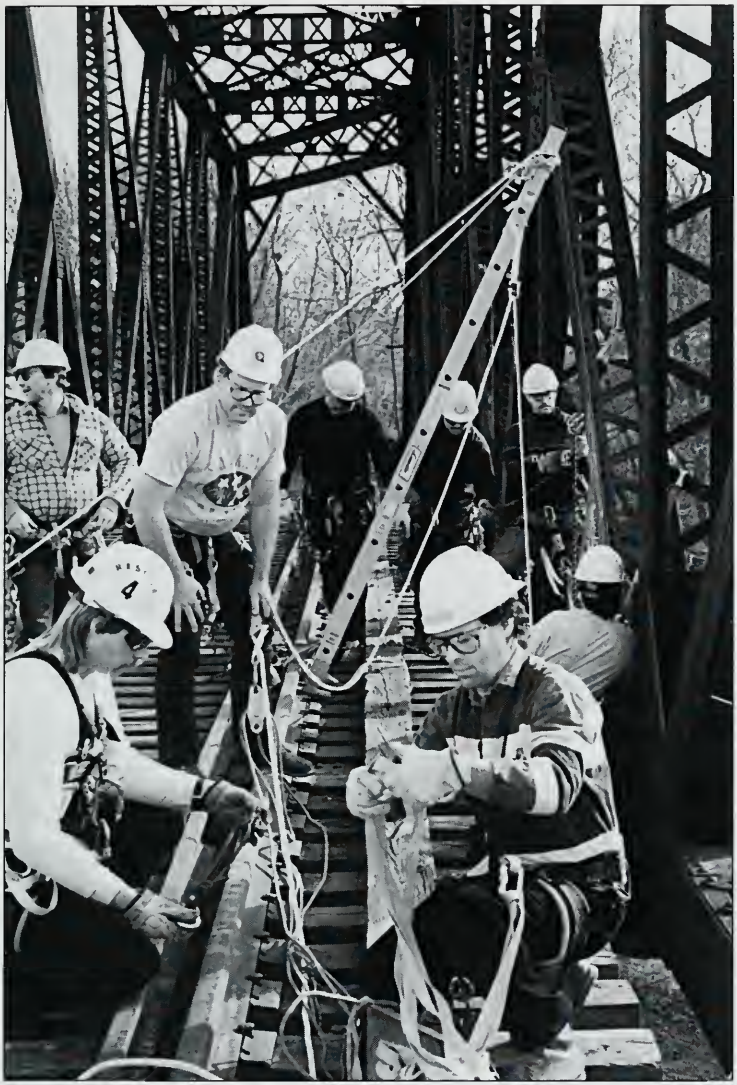
Self-retracting lanyards: These devices are being used by bridge workers and inspectors on several railroads. They come in a variety of lengths and can be used in combination with rail rollers, lifelines, et cetera, to give the user a greater range of movement. They use an inertial breaking mechanism like a seat belt to arrest the fall. A recent innovation has been to use a self-retracting lanyard in combination with roped climbing techniques. This eliminates the need for a belayer (see two-man rope climbing techniques for an explanation). An obvious drawback to this technique is that it requires the climber to backtrack in order to retrieve gear placed on the lead and limits the climber to a single pitch. On short spans, however, this would not be a problem and the device could be used for improved efficiency.

Binoculars: These are not good for much more than a cursory inspection and should only be used on a very limited basis. One of the major requirements of a good bridge inspection is that the inspector get within arms-length of his subject. With the aging bridge population and the increasingly large number of loading cycles on many of our steel structures, this is becoming more and more critical.

Oftentimes a problem area is known to exist on a particular bridge such as pin movement in a top chord that calls for an increase in inspection frequency. In a case like this, it wouldn't hurt to call the condition to the attention of the local track inspector who could check it periodically with binoculars after the bridge inspector has told him what he should be looking for. This would be an acceptable application.

Rock climbing techniques: These techniques offer a great deal of flexibility to the inspector and have recently been adapted for bridge inspection purposes. The advantages of these methods are an ability to reach nearly all areas of a structure with a minimum amount of equipment. Nearly all of the inspector's gear needed during an inspection can be carried on his person. Cost wise, climbing gear is relatively inexpensive, on the order of $1,000 per inspector to get started and roughly half that each subsequent year to replace worn out or expired equipment. It is not necessary to occupy the track during a climbing inspection although care must be exercised in keeping roles and webbing from fouling live tracks and other lanes of traffic.

A downside to this method of inspection is in the amount of training required. Most railroads will need to contract with a consultant for the initial training but should be able to conduct in-house refresher courses once having gained experience. Also on the downside, the inspector must be physically fit. Certain techniques will have to be used with some discretion depending on the individual's physical condition with strain and sprain type injuries being the



Rescue

S.T.A.R.T. Rescue Training, Inc. conducts a rescue demonstration for Conrail bridge inspectors on this out-of-service through-truss bridge near Allentown, Pennsylvania.

major concern.

Rock Climbing Equipment

Rope: Climbing rope is of a special construction known as kernmantle which consists of a core (kern) and protective sheath (mantle). It is further grouped into two types, static and dynamic. Static rope is designed to stretch minimally while dynamic rope is designed to stretch about ten percent of its length to absorb the impact forces generated in a fall. A standard climbing rope is 11 millimeters (7/16") in diameter and 50 meters (165') long although static ropes can often be purchased by the foot.

Harness: A harness is an arrangement of webbing used to attach a rope, webbing or lanyard to the climber and serves to distribute his weight or the impact forces of a fall for greater comfort and safety. The three major types of harnesses are seat, chest, and full body. The seat harness consists of a waist band and leg loops and distributes the forces of a fall around the pelvic area and is often used with a chest harness. The chest harness is designed to be used with the seat harness and should not be used by itself. Its function is to help keep the hanging climber seated in an upright position. It also gives a would-be rescuer a quick and easy attachment point in the center of the wearer's back. The full body harness functions similarly to the combination seat and chest harness. This type of harness is designed to distribute the forces of a fall over a large area of the body.

Webbing: This is a woven synthetic material that is produced either tubular or flat. The ends of a length of webbing are connected by either tying them with a water knot or they are overlapped and stitched. This forms a continuous loop that is useful for anchors which are called runners or slings. Some runners are constructed of a length of webbing with the ends overlapped and stitched to form eyes. Webbing slings and runners are used with carabiners to allow a quick and easy means of connecting rope and other gear.

Carabiners: Are metal links, usually aluminum or steel that have spring loaded gates for clipping ropes, webbing and other pieces of equipment. Carabiners come in locking and nonlocking varieties. Rock climbers use the nonlocking type in applications where one hand is often clinging to a hold and the other hand must clip the climbing rope into the carabiner. During this action, the climber's strength is waning and any fumbling or delay can result in a fall. Here, the risk of falling outweighs the risk of carabiner rollout, a situation where the rope unclips itself from the carabiner during a fall by coming across the gate. The bridge inspector, however, has much greater control over his destiny since a bridge will provide many holds and rest stances. If this is not so, then another form of access must be chosen. For this reason, carabiner rollout proves to be the greater threat to the inspector and locking carabiners are used.

Locking carabiners are grouped in two main types: screw barrel and autolocking. The screw barrel variety must be locked manually by twisting the barrel with the fingers until it locks. The autolocking variety has a spring loaded mechanism that automatically locks the carabiner as soon as the gate is released. This is a valuable feature since it is impossible for the user to forget to lock the carabiner and any movement or pressure against the gate will stand little chance of opening the gate.

Belay plate: This is a small metal plate with two slotted holes through which a climbing rope passes in order to apply friction. The device is anchored and aids the belayer in arresting the fall of a climber.

Rack: A rack is a rappel device usually made of aluminum or steel consisting of a frame with bars that may be added or removed to apply variable friction to the rope during descent. This device is relatively large compared to other rappel devices and is used for long rappels where friction heat buildup can be a problem.

Figure-Eight: This is another type of rappel device usually made of aluminum or steel used to apply friction to a fixed rope for the purpose of controlling a climber's rate of descent. It has two holes; one for attaching it to the harness, and the other through which the rope is passed to apply friction. The figure-eight is usually used for short rappels where

Inspection Cable

At Surety Manufacturing's facilities in Edmonton, Alberta, an engineer demonstrates use of a device which "rolls" through cable attachment points without having to disconnect the shock absorbing lanyard protecting the inspector.

friction heat buildup is not a problem.

Prusik: This is a continuous loop of cord used to attach to a fixed rope by means of a prusik knot. The prusik cord is normally of a smaller diameter than the rope it is attached to and grabs when loaded. Uses include a safety backup for rappelling devices, holding a line in a rescue set up, and used in pairs for ascending a fixed rope especially during self rescue.

Ascenders: These are cammed mechanical devices used in pairs that allow a climber to climb a fixed rope. The ascender is easily slid up the rope by the climber, but under load, tightens on the rope preventing downward movement.

Rock Climbing Techniques

Two-man roped climbing: This technique, also known as lead climbing, can be used on most structures but is most effective on deck girder type bridges where there is adequate head room and a bottom lateral system or flanges to walk on. A dynamic climbing rope connects the two climbers. One man moves at a time while the other man who is anchored to the structure pays out the rope. This rope handling process is called belaying and the anchored climber doing it is called the belayer. It is the belayer's responsibility to catch his partner if he falls. He is aided by either a mechanical belay device or a special knot that will apply friction to the rope.

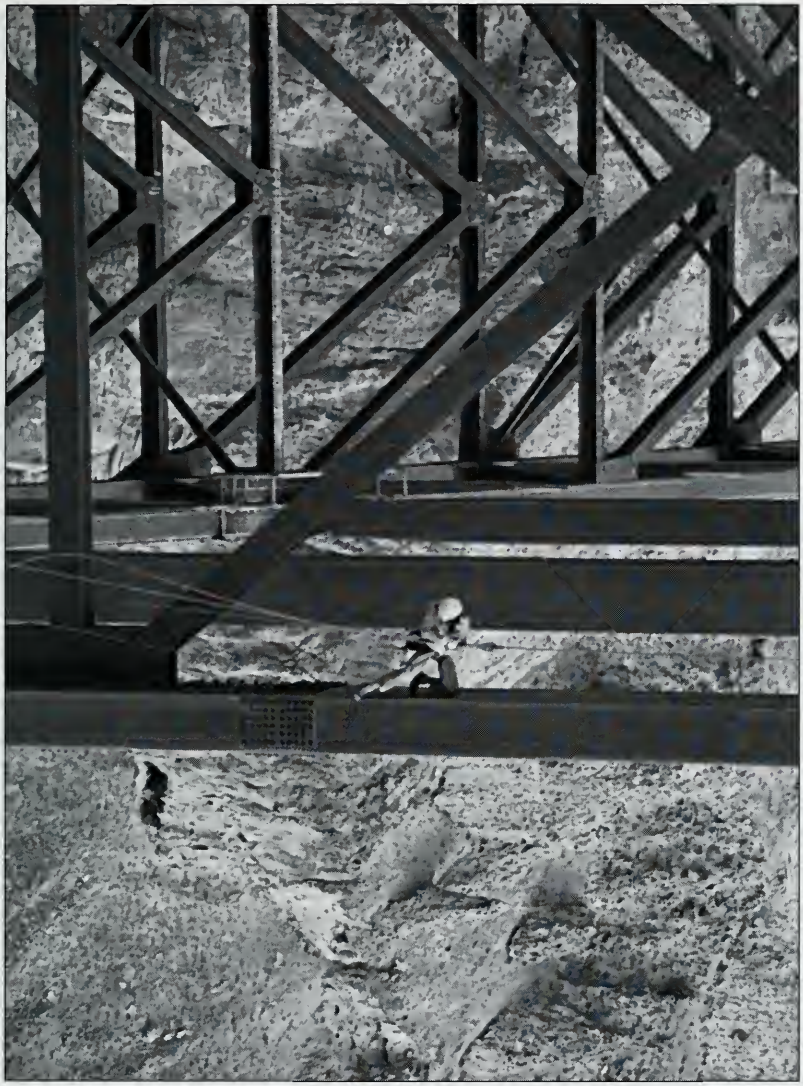
The inspector who is climbing, known as the leader, places intermediate anchors as he moves along to shorten the distance he could potentially fall. These anchors are made up of webbing slings and carabiners. The climber continues to move and inspect until he reaches a convenient stance where he can set up an anchor and belay. The distance traveled between belay points is called a pitch and is generally less than one rope length.

Once the leader has set up an anchor and is ready to belay, roles change. The leader becomes the belayer, and his partner, also known as the second, becomes the climber. As the second climbs toward the belay he will remove the anchor slings placed by the leader. This process is called cleaning. When the second reaches the belay, he has a choice. He can either continue climbing, at which point he becomes the leader, placing intermediate protection points as he goes, or he can stop, hand over the gear he cleaned from the pitch to his partner and repeat the sequence. Choosing the former results in a leap frog type of process, the more efficient since gear doesn't have to be passed and a new belay doesn't have to be set up, while the latter resembles an inchworm. This process is repeated as necessary.

Solo climbing with webbing: This technique allows an inspector the freedom to move independently with a great deal of mobility and still remain protected. It is limited primarily to truss-type bridges. The inspector uses two webbing slings connected to a shock absorber on his harness. He wraps one of these slings once around a structural member and clips it back onto itself with a locking carabiner. This webbing can be slid along the structural member with relative ease and will cinch up tight around the member when weighted for purposes of resting or to arrest a fall.

The second webbing sling is used to move around structural connections to remain continuously protected. This second sling can also be used as a backup anchor if the inspector decides to rest on his primary anchor sling. Although this method is limited primarily to truss type bridges, it can be used on deck girder type structures by prerigging anchor slings from deck level to hang down between the girders. These slings give the inspector something to clip into as he moves along between the girders. A pre-rigged cable is ideal for clipping into. Walkway planks or grating also greatly aid the inspector.

Rappelling: This technique allows an inspector to descend a fixed rope. It is most useful on tall structural elements such as supporting towers that are beyond the reach of an inspection vehicle and where a ground up approach is difficult. The inspector uses a special mechanical device attached to his harness through which the rope passes. This device allows him to slide down the rope and apply friction to control his rate of descent. One hand acts as the brake controlling the feed of rope through the rappel device. A static rope is preferred for



Rappelling

A Burgess & Niple bridge inspector descends fixed ropes to gain access to pin connections on the Perrine Bridge in Idaho.

the rappelling operation. A static rope is designed to stretch minimally which gives the rappeller a less bouncy ride and also feeds easier through the rappel device. This static rope is also able to handle the abuse of friction heat buildup associated with rappelling. It is usually best to avoid subjecting your dynamic climbing rope to this type of use.

There are a few ways of adding redundancy to the rappel. One way is to rappel simultaneously down two ropes independently anchored at the top. Another way is to attach a prusik to the rope above the rappel device, connecting the other end back to an independent locking carabiner on your harness. The prusik will lock up on the fixed rope when weighted serving to back up the rappel in the unlikely event the rappel device fails. The prusik must be slid along the rope with the free hand to keep it from inadvertently locking up. This common mistake usually happens as a result of not paying enough attention and can be quite frustrating especially if the knot has gotten out of reach.

Another back up method is to place a helper on the ground to hold the free end of rope. This will slow or stop the rappeller just as if the rappeller had applied the force with his brake hand himself. While this technique protects against human error, it does nothing to guard against equipment failure. Probably the most foolproof backup method is the use of an independent belay during rappel. Both of these last two methods impose the burden of requiring an additional man for each rappel set up and may not always be practical depending on available manpower.

Ascending: This refers to climbing a fixed rope. This is done with the aid of either mechanical devices or a specially designed knot, i.e. prusik knot. Because of the exertion required of this method, it is generally not the inspector's first choice. Ascending can sometimes be very useful in regaining your original elevation after rappelling down to a relatively inaccessible location such as the top of a pier.

The most popular use of ascending, however, is in self rescue. If a climber has taken a fall, ascenders or prusiks can often be used to regain a stance. Ascending is accomplished by attaching two mechanical ascenders or prusiks to a fixed rope, one above the other. The upper ascender is connected to the climber's harness with a webbing sling and locking carabiner while the lower ascender is connected to his foot or feet. The ascenders are easily slid up the rope, but when weighted they lock up preventing any downward movement. By alternately sliding and weighting the ascenders, a climber can move up the rope. This technique takes some practice to use effectively. Most people when they first try it, wear themselves out before they make much progress and tend to use their arms too much for muscling up the rope. Better results are obtained by relying on the legs for the muscle and using the arms primarily for balance.

Communication: When two climbers are working together and depending on one another for protection, a simple yet effective means of communicating is essential. Usually the climbers will be within earshot of one another if they are connected by a rope. Oftentimes, however, traffic, wind, or moving water will interfere with the ability of one inspector to hear the other and radios will become necessary. Small portable units are available, although expensive, and can be used for this purpose. An added feature that has proven useful is a "bone phone" attachment. This device inserts into and around the ear much like a hearing aid. In addition to receiving, the wearer can transmit by means of a voice-actuated device that uses the jawbone to conduct the sound.

A standard set of calls has been in use for many years by climbers and provides an effective way for the climber to communicate with the belayer. This standard is extremely useful since it uses short phrases that are easily recognized, even when the call is barely audible. These signals have been carefully devised to communicate common messages and avoid misunderstanding. One set of calls ensures that the belay is set up before the climber moves away from his anchor.

Climber:	"On belay?"
Belayer:	"Belay on."
Climber:	"Climbing."
Belayer:	"Climb on."

You can see the redundancy built into this set of calls. It is very much like asking for a password where two independent responses are required. These calls should be practiced with professionalism in the same way a pilot goes over his preflight checklist. Other common calls used during rope climbing are:

Slack: Used by the climber when he wants more rope or slack.

Up rope: Used by the climber when he wants the rope taken in, usually when too much slack has been accumulated in the system. A common mistake is to say, "Take up the slack." Sometimes background noises will chop off syllables of a communication. In this case, the call, "Take up the slack," comes across as, "___ __ ___ slack," which conveys the exact opposite meaning intended.

Rescue: This is probably the most difficult area that must be addressed. The FRA requires that prompt rescue be provided. Prompt is left perfectly vague and at present there is no precedent to reference. Since every rescue situation will be different, judgment will come into play. Planning and training will prepare the rescuers to act in an organized manner and give them the confidence needed to make decisions and perform under the pressure of an emergency. The first decision that will have to be made is whether or not to seek outside help. If an injury is involved, this decision will be made for you. Radios or cellular phones should be available and their locations and proper use known by every member of the team. Emergency contact telephone numbers for each work location should be obtained in advance, reviewed during the daily job safety briefing, and posted conspicuously for ready reference.

Unfortunately, not all of these emergency contacts, especially some volunteer groups, are equipped or qualified to perform rescues involving climbing type accidents. Also, the situation itself may not allow you the luxury of time needed to bring in rescuers from a distant location. For this reason, some railroads are taking a proactive role in training and equipping their inspectors in carrying out fall victim rescue themselves.

Rescue training should start with fundamentals such as how to set up and operate essential equipment. The participants should be instructed in how to evaluate a situation, so that the rescue can be carried out safely, avoiding injury to rescuers and further injury to the victim. Rescue alternatives should be discussed. By far the easiest form of rescue is self rescue. It obviously requires that the victim be conscious and capable of performing the operation. The most simple form of self rescue involves reaching or swinging to a handhold or foothold in order to regain a protected stance. Caution must be exercised however. If the system sustained damage during the fall or if the rope of webbing suspending the fallen climber is in contact with an unprotected sharp edge, then the compromised portion of the system will have to be isolated. This will require assistance.

If the system is okay after the fall and the climber can't reach a hold to regain a stance, then ascenders or prusiks can be used to climb up the rope. Prusiks are commonly carried on the person just in case such a need arises. They are light and hardly noticeable compared to mechanical ascenders.

If self rescue is not possible, the two other primary forms of rescue are raising and lowering. Lowering is almost always the easier method to perform but site conditions will often prevent its use. Raising usually requires a mechanical advantage and hence specialized equipment. Block and tackle and winches are commonly used for this purpose. These are usually used with a tripod or boom although some can be connected to the structure itself. A boom truck provides a convenient attachment point for rescue equipment. It must be understood, however, that hydraulic or other power-operated winches on boom trucks are not man-rated and can cause serious injury to a victim during the raise if an obstacle is encountered.

Rescue training should progress over time introducing different rescue scenarios that may be encountered. At more advanced levels, participants should be required to solve problems and make decisions in choosing between alternative methods rather than jut mechanically perform tasks. If "live" victims are used for these exercises, they should always be backed up by an independent belay in the event of a failure.

It would be highly beneficial for anyone who might find themselves involved in a rescue to attend a first aid training course. As a bare minimum, it should be pointed out during your rescue training that certain conditions such as neck and back pain injuries can be aggravated by moving the victim. These situations must be handled only by trained medical professionals.

Training

In order for the bridge inspector to take full advantage of the recent revision to FRA Bridge Worker Safety Rules, the railroad must provide, among other things, training in the use of safe climbing procedures. The details of what to include in this training program are left to the railroad. Also left to the discretion of the railroad is how long and how often should training be conducted in order to keep the inspectors sharp in the use of their techniques. Survey results show that for climbing techniques, railroads on average put their inspectors through a three-day initial course. Since most railroads do not have experience in this area, this initial training is usually left to a consultant. Subsequent interim training in climbing techniques is conducted less than once a year on average, and that training lasts between one and one-half and two days per session. Some of the topics being taught in current training programs are:

Three-point contact: This means that either a hand or two feet or a foot and two hands are in contact with the structures at all times. This was a general rule of thumb for rock and mountain climbers in the early days of the sport when equipment was less forgiving than it is today. Although the sport climbers of today may have abandoned this philosophy in a quest for greater challenge, this basic rule applies to the work setting where risk must be kept to a minimum and safety remains the number one priority.

Hazards: Look out for and be aware of hazards such as:

- grease, water, ice, mud or other slippery conditions.
- sharp or rough edges that could cut or snag you, your clothing, or equipment.
- vibrations from moving loads.
- strong wind.
- traffic on, over, or under structure.
- animals and insects.

Anchor-off: Although not an FRA requirement, some railroads are recommending, and some are requiring, that when an inspector has reached a location on a structure where he will remain for an extended period of time or will be engaged in taking measurements, photographs, sketching, et cetera, that he tie off to the structure.

Additional Notes on Training

Train with the same equipment that will be used on the job. If receiving training from a consultant and that consultant is providing the equipment, ensure that the equipment being used meets FRA requirements where necessary and is identical or nearly identical to the gear the inspectors will be using on the job.

It only makes good sense whenever possible to conduct training on railroad bridges, preferably your own, since this is familiar ground and this is where the techniques must apply. An extension of this idea is to conduct training on one of your large scale structures and combine the training with an actual inspection while the team is assembled. Training can oftentimes be started on the smaller scale approach spans and as the training progresses so does the size of structure and the exposure to height.

Team experienced climbers with new climbers when possible. This type of on-the-job training will greatly help the new climber develop sound techniques.

Use a team approach on large scale structures. Some inspectors will never be as comfortable with some climbing techniques as others. This is especially true when dealing with extreme heights. Instead of trying to force the issue, try to match individual inspectors' natural abilities with corresponding jobs. Those inspectors better suited to climbing can be placed in that role while others may be better suited in a support function such as ground man, flagman, equipment manager, or vehicle operator, say for shuttling inspectors and equipment. Although there will usually be some healthy tension or jitters when beginning a large scale inspection at heights, a strong camaraderie can be born using this team approach.

Train two trainers on each territory. They will become a reliable and familiar source of information when questions arise. They can also rely on each other and use a team approach when conducting training. Also, if one trainer is transferred or bumped out of his position, you stand less of a chance of being left without a qualified trainer.

Encourage physical conditioning. Some railroads have initiated stretching programs in order to cut down on some of the common strain/sprain type injuries sustained on the job. Climbing places a greater physical demand on the inspector than many activities. Some of the techniques will have to be used with discretion depending on the individual's physical condition. An overall fitness program addressing strength, endurance, and flexibility will greatly reduce the likelihood of sustaining an injury while performing climbing techniques.

Conclusion

The equipment and techniques available today will undoubtedly make possible a safer and more efficient inspection than was possible in the past. Proper training will ensure the inspector can conduct his job safely by arming him with the knowledge and skills necessary to choose between alternative systems and then use that chosen system to its best advantage. Proper planning in the event of an accident and practice in the use of rescue procedures will give the inspector the confidence needed to do a quality job and then safely return to his family when that job is done.

Even though we have made great strides in protecting our bridge inspectors, a false sense of security must not be developed. Every inspector must regularly check his gear for damage, wear and proper set up. He must also remain alert and aware of the consequences of a fall. There are no shortcuts or pat answers. You can't simply tell an inspector, "don't look down." He still has to inspect that bottom chord. You can, however, arm him with skills and equipment necessary to do his job safely, thoroughly, and efficiently.

Thank you very much. (Applause)

If there aren't any more questions I need to thank a few people. I first want to thank the committee members on the team who provided a lot of information and helped me with photographs. I want to thank the directors of the board for the B&B Association especially Pat Barrett who was our sponsor and offered a lot of guidance as we went through this process.

I also want to thank the railroad officials. A lot of you are here who answered the surveys that we sent out. Also Erol Kaslan from CalTran helped out a lot and you saw some of the slides that they provided. Glen Given of Kentucky DOT helped a lot, as well. I want to thank the folks from Conrail, Bruce Willbrant and Jim Richter, Charlie Yordy, Tony Castrucci, and Jerry Davis who critiqued and helped going over this presentation. Also Tom Olechowski, who is now with Amtrak, was a big help as was Kurt Braunle with Start Rescue Training and Neil Nucci. Finally, I want to thank my wife, Lynette, who is my climbing partner and helped a lot with this presentation. Thank you very much. (Applause)

Mr. Lileikis: Thank you, Steve, for a very well prepared presentation. I might add Steve has prepared an excellent complimentary handout which includes definitions of all the terms he used and has a very good introduction to the methods and concepts used here. That report can be found at the back.

Next we have a video on climbing. To comment on it, we have Paul Roddy also of Conrail. Paul started with the Penn Central in the B&B department and served in a variety of positions in the B&B department including superintendent of maintenance and superintendent of bridge inspection. Currently he is the senior system structural inspector for Conrail. Please welcome Paul Roddy. (Applause)

CLIMBING

Paul Roddy

Senior System Structural Inspector
Conrail

Good afternoon. Steve just gave you a great overview of the mountain style of bridge inspection. I have a companion piece that really fits very well with the slide presentation that he has just done. It's a short 12 minute video which really shows these techniques in action.

When we first talked about this concept on Conrail, there was one recurring question that kept coming up. Can this new inspection style be mastered by our existing inspection personnel? As you will see, the answer was a resounding yes. Conrail has 47 inspectors who range in age from 31 to 62, none of whom had any previous rope climbing experience.

As Steve indicated earlier, team building and certification should take place as part of a comprehensive information program. Last year, the second annual recertification of the Almay division bridge inspection team was tied into a special inspection of Conrail's tallest structure. Twelve inspectors with a median age of 46 years and two years of practical rope experience used the belay and repel techniques. The slender towers were built in 1875 on this bridge. A lack of handholds on the tower would have required the use of a crane and basket to inspect each tower connection. This would have required extensive track usage and would not have allowed the inspection of the bridge while under traffic.

In three weeks time, we were able to complete a hands-on inspection of every member and every connection of a 800-foot long truss deck girder bridge which is 236 feet tall at center span on 20-foot tall piers and at the edge of a 70-foot water fall.

HIGH TIMES — BRIDGE INSPECTION — MOUNTAINEER STYLE
A CONRAIL VIDEO

The challenge: The safe inspection of a bridge built in 1875, which carries 15 million gross tons annually, is 820 feet long, 236 feet high, and was built at the edge of a 70-foot waterfall.

Conrail's tallest bridge is located on the Southern Tier Line, over the Genesee River Gorge at Portageville, New York, just south of Rochester. The location is one of the most breathtaking in New York State, in the middle of Letchworth State Park.

The Erie Railroad, under the direction of Superintendent Silas Seymor, built the first bridge to cross the river at this location. Commencing construction in 1850, the first train crossed on August 9, 1852. The bridge was built of timber based on a design suggested by a young boy which doubled up timbers during construction to allow for the removal of any timber for repair in the future. The concept was sound and the bridge became the largest

wooden structure in the world, with more than 300 acres of pine timber, totaling more than 1,600,000 board feet, used in its construction. The original construction cost was $175,000. Unfortunately the bridge had an Achilles' Heel — fire!

The railroad was acutely aware of the bridge's potential frailty and contracted for the design and construction of a new wrought iron truss bridge. The year was 1875, the component parts for the new bridge were in route when the inevitable happened. A fire started that engulfed the bridge in a conflagration that lit the night as bright as day.

The "new" bridge was assembled on the footings of the timber trestle in forty-seven days. Numerous repair and steel strengthening projects have been made over the years, yet the basic structure remains and is still in active rail service.

The Portage Bridge Portageville, New York. Built 1875 Rising 238 feet above the 70 foot Letchworth Park Middle Falls of the Genesee River.

In 1992 Conrail had initiated an innovative training program utilizing state-of-the-art rock climbing techniques and equipment for bridge inspection. The program was developed by senior structural inspector Steve Ross of Conrail's structures department. He pursued its implementation based on his personal knowledge and experience as an avid mountain climbing enthusiast, knowing full well that a properly trained and equipped inspector could better access bridge components with full safety.

The initial training of inspection personnel consisted of one half day of classroom and two and one half days of field training. A basic introductory type of course presentation

including knot tying and general applications was taught. Practical application on different types of bridges gave inspectors the basics needed to safely implement the program. After successfully completing the initial orientation program, the inspectors were each equipped with approximately one thousand dollars worth of equipment.

In the spring of 1994, a hands-on inspection of the entire Portage bridge was scheduled, 118 years after the "new" bridge was built. The bridge inspection team from the Albany Division together with Conrail's system bridge inspection staff set out to inspect every inch of the bridge looking for potential defects. The results of the inspection would become the basis for shaping long range future repair and maintenance plans for the bridge.

The inspection was staged from track level with inspectors suspended from dual 11mm ropes. The entire inspection was conducted without interruption to train traffic which had the benefit of allowing observation of individual components up close while under load.

Two basic processes were used to move around the bridge utilizing the climbing equipment called belaying and rappelling. Belaying is the process of moving horizontally across the structure while on a tether line protected by a climbing partner, while rappelling is the process of moving from the highest point to the lowest by sliding down a pair of ropes using friction devices to control the rate of descent.

The west tower of the bridge is the shortest at 47 feet tall. The entire team rappelled down this tower to ensure that everyone was confident with the procedures to be used. Despite their training and experience, a heightened level of apprehension was felt by all when inspecting the 236 foot towers which are adjacent to the 70 foot waterfall. The effect was one of leaning backwards off a 30 story building. The supervisor of bridge inspection, Bob Schmid, was understated when he said, "To back yourself off into oblivion at 236 feet is a little scary."

Four climbers worked their way down each tower leg simultaneously, one man per tower leg, allowing them to keep in eye contact with each other. The mobility of the inspectors allowed them to slide down at a controlled rate, then stop at any location desired and "lock off." Once the inspector was in a locked position, he had both hands free to examine the individual bridge members, take notes or photographs. He could easily move horizontally by swinging sideways, accessing the diagonal tie rods which would have been very difficult by any other means.

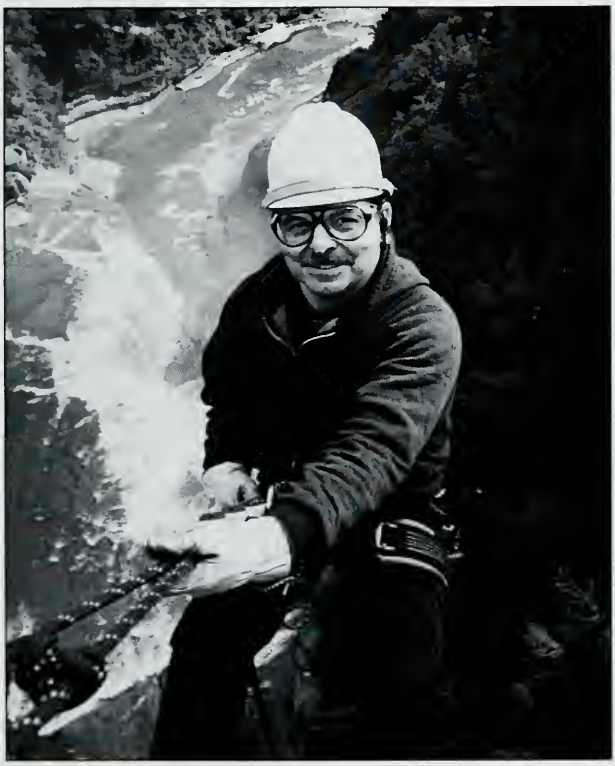
While climbing, the inspectors had a unique vantage point for inspecting the bridge and to observe the beauty of the thousand acre park in which it's located. The inspectors drew an awe-struck crowd of hikers and picnickers who had the unexpected pleasure of watching the climbers "fly through the air with the greatest of ease."

One unique issue which presented itself during the inspection was impaired communications. Due to the roar of the waterfalls and great height, talking with the climbers would be impossible. Even hand signals would have been impractical. The solution was a high tech, hands-free "bone phone." Using a small ear plug which acted as both microphone and receiver, the team was able to talk without the interferences of the background noise from the water.

When the inspection was completed, there was a sense of camaraderie and accomplishment felt by the team. The team members included Conrail's Albany Division bridge inspectors Dave Cook, Neil Daniels, Bill Garcia, Carm Guyette, Joe Hollander, Rick Packer, Barry Pekarsky, Dave Scatko, Jim Thomas, supervisor of inspection Bob Schmid, system steel inspector Willy Gall, and system structural inspectors Steve Ross and Paul Roddy.

This inspection proved to be safe, thorough, and cost effective. With training and the right equipment, our inspection team has gained the kind of access to high steel that only Spider Man might have been able to obtain. The mountaineer style of bridge inspection has been a very successful advancement in Conrail's bridge management program, meeting the rigorous needs of unrestricted mobility, complete safety and the assurance of uninterrupted train traffic.

On high steel. Inspectors take on the role of a real life "Spider Man".



The first step. Conrail bridge inspector Carmi Guyette starting to rappel from the top of Portage Bridge. From deck level to the base of the falls is more than 300 feet.

Inspectors Joe Hollander and Paul Roddy rappelling down the tower legs.

Inspector Carmi Guyette setting up his rappel rack. This is the friction device he will be using to control his descent down the dual 11mm ropes.

Inspector Dave Scatko sets cut protection for the rappel ropes to ensure their not being damaged by abrasion.

Thank you very much. (Applause)

Mr. Lileikis: Paul, thank you very much.

Before we close our session for today, I want to remind everyone to please fill out the red survey cards. They are helpful for us to take a look at how we are doing with our presentations. We would also appreciate your filling out the yellow cards which give us ideas for additional topics and things that you would like to see presented at subsequent conferences. We do read those. We do use those to try and come up with presentations to meet those as requested by the membership.

Are there any other questions from anybody? If there is no other business, we'll adjourn for the day. Thank you.

(Adjourn)

JOINT SESSION

Tuesday, September 26, 1995

President Van Huis: Good morning and welcome to the second joint session of the 1995 conference. I have some updated numbers for everybody and they are B&B at 86, roadmasters at 139, guests at 76, and suppliers at 252 for a total of 553 attendees. There are also 83 spouses or significant others.

It is indeed an honor for me this morning to introduce our keynote speaker, Mr. Edward Burkhardt. Mr. Burkhardt is president and chief executive officer of the Wisconsin Central Limited which began operations on October 11, 1987. Wisconsin Central is the larger of the regional railroads spun off from Class Is in recent years and is a subsidiary of the holding company, Wisconsin Central Transportation Corporation.

Ed is also president and director of each of the WCTC subsidiaries. He is president of the WCTC Fox Valley and Western Limited which purchased the operating rail assets of the Green Bay and Western Railroad, Ahnapee and Western Railway and Fox River Valley Railroad in 1993. Also in 1993, WCTC acquired a 29 percent stock interest in New Zealand Rail Limited which is the only railroad in New Zealand. In 1994, WCTC acquired the railroad operations of the Algoma Central Corporation and continues to operate under the name Algoma Central Railway. The transaction received regulatory approval from the National Transportation Agency of Canada on December 22, 1994. Ed is also president and treasurer of the San Luis Central Railroad, a shortline located in southern Colorado.

Prior to Ed's WCTC involvement, he spent 20 years with the former Chicago & Northwestern where he was most recently vice-president transportation. He also served at C&NW as assistant general manager staff, general superintendent transportation, assistant vice-president transportation, and vice-president marketing.

Prior to joining the C&NW, Ed was employed with Wabash, Norfolk Western and the Great Northern Railroad. He holds memberships in the Union League Club and Economic Club of Chicago. Ed is a past president of the Western Railway Club and is a director of the both the Lake Superior Museum of Transportation in Duluth and the John W. Barriger III, National Railway Library in St. Louis.

Ed also serves on the executive committee of the Regional Railroads of America and United States/New Zealand Council. In February of 1995, Ed was appointed honorary counsel to New Zealand from Chicago. Please join me in welcoming Mr. Burkhardt. (Applause)

KEYNOTE ADDRESS

Ed Burkhardt

President and Chief Executive Officer
Wisconsin Central Transportation Company

Thank you, John. It's a pleasure to be with the people who maintain our industry and this function is the most vital of what we do. It is nice to be with you today.

When Wisconsin Central started up, we realized that we had 2,000 miles of railroad and a revenue per mile of about $50,000. This compared with the average revenue per mile of the Class Is in our industry of close to $300,000. Put another way, we could say that we had a lot of railroad relative to the business that we were handling. This put extra pressure and continues today to put extra pressure on our maintenance operations to see that they are done efficiently and at the very best cost.

In addition to having that adverse relationship between our revenues and the size of our physical plant, we very quickly found out that there was a lot of deferred maintenance on the railroad. In our industry when lines are placed for sale, they generally have not been maintained at a high standard by the seller railroad for some years before that as the business was allowed to decline. So we have had to literally boot strap our way back with forever increasing tie and rail programs, ballast and everything else that you do in this business to have your physical property in shape. This has all been accomplished at the same time that we have had a doubling in our business.

Today Wisconsin Central has gotten like several other railroads in your industry. We are pushing capacity in various locations on our system. We are continuing to spend money to correct those kinds of problems. Those are what we call high class problems because they bring revenue with them. Today, our revenue per mile is over $90,000 which still places us in the low end of all railroads in terms of our revenue per mile, but it is a lot more comfortable to operate at that level than it was. We continue, relatively speaking, to put more money into capital than any other railroad that I know of with our capital expenditures for roadway and rolling stock generally exceeding $100 million out of a railroad with about $250 million in total revenue.

The board of directors continually ask me when this is going to stop and when we are going to be able to have some cash to use for things like paying dividends. I keep telling them that it is around the corner, but the corner keeps receding as the spending to keep ourselves in good competitive shape requirements never seems to end. Without a doubt, we have gained on it considerably and today we can say that we have a well maintained railroad with few slow orders and have fixed a lot of the inherent problems that were out there at the time of acquisition.

Those of us who have been in this industry for a number of years have seen it all, I guess, in terms of the affect on engineering organizations of the roller coaster rides of our industry. In my days on the C&NW, I saw declines in terms of the physical plant that was created by economic malnutrition. Management tried to operate within a budget. To put it another way, the sheet wasn't big enough for the bed and every time we tried to cover the shoulders, the feet stuck out. So the net effect was that unfortunately the engineering organizations or other maintenance functions generally seem to be the ones that got what was left over. So we had a steadily deteriorating physical plant for a number of years.

Having gone through that experience, the one thing that I learned from it is I never want to see that situation again because once you lose maintenance condition in this industry, it is very hard to dig yourself out of that hole. It's hard to maintain on a current basis. It is that

much harder to maintain and rebuild a railroad that has been allowed to slip. Engineering people look for a managerial consistency which unfortunately, often hasn't been there. Without criticizing top management of railroads excessively, they have been limited by the number of dollars that they have to work with.

The industry as a whole has turned the corner on that and we are in a whole lot better shape today. One of the continuing issues I see that we have to address is the development of people. For many years, this industry was shrinking. Perhaps we were shrinking in terms of the rank and file employees and we were also shrinking with respect to management. We were not developing people. We were giving people the gate. I think those days are behind us and they are certainly behind us at Wisconsin Central wherein we took the hit on day one. We have progressively built our organization since October of 1987.

I feel that we are behind in developing people. We need to put more resources into training and the development of people has to be put much higher on the managerial agenda. That applies not only to the rank and file but very much to the management. We follow the old style, which I think most railroads do, of moving people from the ranks into management and feeling that they will learn by osmosis, by organization, by observation, and by working alongside other officers. Of course, to a certain extent that is true. However, it doesn't seem sufficient today and we need to develop our young managers because they are the people that are going to be running the railroads in the future.

Stabilization of jobs is an important issue and we work very diligently at Wisconsin Central to accomplish that. We are fortunate that we have a largely non-union environment which makes that easier because the craft system in effect on the union railroads lends itself very much to the extreme cycles in the number of jobs that are available. For example, operating in a northern climate as we do, usually we end our production work each year in mid November. Most recently because of the amount of work to be done, it seems to be pushing Christmas. Well, that really ties into when the ground freezes at these latitudes and we offer jobs to our production employees in the car and locomotive shops and our mechanical people are glad to have that extra help during that period. Each year, a few track people tend to stay behind in the mechanical department because they find that they like that type of work. I am looking at that as very healthy. People should have the opportunity to shift around and change jobs within the company and to go where they are best suited.

By offering year-round jobs to people, we have obviously solved one problem that goes with the seasonal work. We also push for productivity and the requirements are no less in this area and we are using every method we know of to increase the output of our people. For this reason, and for the reason that I cited early on, with our large physical plant relative to our revenues, we are able to get work done for less. In fact, I believe that we have costs per unit, maintenance-of-way or construction work, that are in the area of where a good track contractor would operate. We can use track contractors and we generally do when we get overloaded with our own work. However, occasionally we go the other way and if we have people and not sufficient work within the particular area for them, we will tackle contract jobs such as industrial sidings and so on and find that we can be very price competitive there.

Running a non-union company has just the opposite results as many of you might think. In fact, it's hard work. In a lot of respects, it is more difficult than operating under a union agreement because it puts the onus on management to be decent to their work force, to be flexible, to respect the needs of the people at the same time that you are getting the company's work done and maintaining principles of high productivity and safety. This really is pressure on management. It's a different type of pressure than people who have been brought up under a union agreement are used to. But we have been successful with that as is evidenced by the fact that we have never had an organizing campaign in the maintenance areas. We have had them amongst our locomotive engineers and our conductors which have not been successful campaigns from the standpoint of the organizers, but we have never had them in the maintenance functions.

Realistic wages are important. We don't pay as high as the Class Is but we pay a good living wage that is well above the prevailing wage in the geographic territory that we serve. That is an area where the larger unionized railroads have a problem in terms of wages being excessive for the job that is being done in many cases. In some other cases, the wages are not sufficient where highly skilled work is concerned. This is an area that I suggest that you, as maintenance managers, keep a dialogue going with your labor relations department because you do need some help from these people.

Work methods and productivity are always high on the agenda and this is why we have conferences such as this to share information as to what people are doing to get that productivity.

In another area that Class Is and other railroads operating under union agreements need some help in is the right to contract out. Ultimately, this is one of the managerial rights that is necessary to have if you are going to run a truly cost-effective organization. Your own internal people should never be benchmarked against what it would cost to get the work done outside with competent contractors. If your own people are not up to the test, then what you have to do, obviously, is find out why not and correct it. As long as the unions have a restriction on contracting out work, they don't have to be efficient and they are protected. That is certainly one of the major items going to the heart of what the recent dispute concerning Amtrak funding and what is going on in Congress. Everybody knows that Amtrak could get their shop work and other functions done outside for a whole lot less than what they can do inside. As the Congress debates changing the regulations there, the fact is that the same principles apply throughout the rest of our industry.

We found the Wisconsin Central experience in international operations to be very interesting. New Zealand has a well maintained railroad. It has mostly welded rail. It's a 3-foot 6-inch gauge system. It operates very similar to high tonnage railroads in North America. There is a lot of centralized traffic control and the rest of the railroad operates on track warrant system just like at home. They operate at relatively high speeds with freight speed limits of 50 to 60 miles per hour. They run a lot of trains. We found we were able to bring quite a bit of North American technology to them that they had not used in the past. In fact, we are in the process of reorganizing the maintenance operation based on our model.

In one respect, though, we found technologically speaking that they were right up with us and in some places, ahead of us, and we brought back some interesting ideas in the marketing and operations area from them. It's a system of approximately 2,500 miles on both New Zealand islands. Part of the railroad is electrified. It is generally in excellent condition with all kinds of concrete cross ties and they have a condition that would be quite familiar to North American railroad people.

I would say overall that I have never been so optimistic about our industry and about our prospects. Whether you realize it or not, you are a branch of the marketing department and so am I and so are all of our people. In the food chain of the railroad industry, the customer is on top, the marketing people who cater to the customers' needs and serves as the interface between the companies come next and all the rest of us are below serving the customer requirements. If we do that well, we will have success. If we do that poorly, we have a big problem on our hands.

Maintenance operations are a vital necessity because the railroad that is not well maintained cannot maintain good track speeds. It doesn't have capacity and is not going to be competitive. That's what it all boils down to.

I am interested, for example, in the interplay that goes on between marketing and engineering people about industrial track facilities. We can provide facilities for our customer at costs that range from prohibitive down to very competitive. A lot of this depends on a philosophical bent within the management of the company. For example, you can use second-hand rail at reasonable pricing and do a job cheaply, or you can insist on everything

being new and perfect and beyond the standards that have been employed before. Pretty soon you will have a price that is so high that the customer says they will stick with trucks because it is easier for them to do that than to build track into their facilities.

It is interesting how we worked that out in that our marketing and engineering people worked very closely to the point where I think our engineering people at times are a branch of the marketing department. Coming from me, that's a great compliment. The engineering requirements in the whole business, again, is really the key to what we do.

I have never been so aware of that as investigating the privatization of railroads in the United Kingdom which we have been looking at recently. The Europeans have adopted a model where they will sign off the infrastructure in one direction into one company and then they will create operating companies to run on the infrastructure and another in another direction. So in effect, the operating company that runs the trains, solicits the business, and deals with the customers, will be a different organization than those that maintain the track, signals, structures, bridges, communication, and so on. Everything that I have seen is that this is a very serious mistake because of the lack of coordination in terms of meeting the commercial needs of the company. It will be very interesting to see whether that system, in fact, holds up under the pressure of the marketplace.

Overall, the support that management and this industry gets from their engineering people is extraordinary. Many of you have been through the period of decline in the industry where we were forever losing ground in terms of the condition of our physical plant. You have gone through the phase where money started to become available through some of the 501 and 505 programs back in the 1970s and had to gear up engineering organizations that have withered on the vine to even spend the money.

Since the passage of the Staggers Act, you have been part of an industry that has steadily gained ground and can actually be called resurgent today. Traffic has increased and this has put tremendous pressure on the infrastructure which still is not in exceedingly good condition.

When there is pressure on the infrastructure, there is pressure on the people to manage the infrastructure and you are handling that very well. I can say, as chief executive of a railroad, that our engineering people are one of the great sources of strength that I have and I feel that is true throughout the industry.

It's a pleasure to be with you here. (Applause)

President Van Huis: Thank you, Ed.

Our next presentation is entitled Managing the Risk of Railroad Construction Projects and the presenter is Timothy Galarnyk, corporate risk manager and manager of railroad operations for Lunda Construction Company.

Tim has been with Lunda since 1981 and has been actively involved in changing the way insurance is acquired at his company as well as developing a working and effective safety program.

Lunda Construction Company was the recipient of the 1994 National Rail Contractors and Railway Track and Structures category three safety award and received numerous other local and national awards for safety and construction excellence.

It is my pleasure to introduce Timothy Galarnyk.

MANAGING THE RISK OF RAILROAD CONSTRUCTION PROJECTS

Timothy Galarnyk

Corporate Risk Manager and Manager of Railroad Construction Operations
Lunda Construction Company

Thank you, John, for the introduction. I spent about two hours writing a presentation for this and here are the efforts of my work. I probably won't follow my script because I believe that there are a lot of things that I wanted to talk about that should be talked about off-the-cuff. I also don't want in writing what I have talked about. (Laughter)

I will talk about two different topics. I am going to split my presentation into two equal sections. The first one is insuring the risk and how to purchase insurance from the standpoint of a railroad representative or a contracting officer or railroad engineer.

The first issue is railroad protective liability insurance. What does it really cover and why would we spend one percent of the total construction contract to purchase a railroad protective policy? What I have been able to do in the last two months is to find out that a railroad protective policy is essentially a policy that doesn't cover very much. If you have a contractor who has a general liability policy limit of, say, one million dollars, and an excess limit, let's say, of five million dollars, what you have, in essence, is a six million dollar railroad protective policy because the manuscript form, and you need to read it as they are essentially the same for all insurance carriers, covers the work of the contractor. In fact, the definition of the word "work" is "Work performed by the contractor or operations of the contractor including materials, parts, and equipment furnished in connection with the work of the contractor." It has to stem from the contractors' work.

In that case, the general liability policy is going to cover first. The general liability policy doesn't cost any more than what the contract has already specified. So why spend an additional one percent of the contract to buy a railroad protective policy when it doesn't really cover anything.

The loss has to arise out of the work on the project at the work site in connection with the contractor's work. So you ask yourself how you are going to protect yourselves. Let's get to the general liability policy. Let's add the railroad as an additional protected person, let's add the railroad as an additional insured, or let's add the railroad as an additional named insured. Which one of those three categories are most appropriate for you?

When you take a look at the language of a general liability policy, there will be some language in there talking about additional protected person. But then there is an endorsement on the policy that has to be used in order to actually add the railroad as an additional protected person or an additional insured or an additional named insured.

Recently the Missouri Court of Appeals for the Western District of Missouri just refused to apply an indemnity agreement on a railroad contract. In this case, the contractor was engaged by the railroad to replace a railroad bridge. The contract contained an indemnification agreement by which the contractor agreed to indemnify the railroad for any claims arising in any manner out of or in connection with the work.

A truck driver delivering rock to the jobsite was injured by a collision with one of the railroad's trains at a railroad crossing about two miles from the jobsite. The driver brought suit. The railroad sought indemnification from the contractor and the court denied it. The court says, "This case finds that the agreement in this case becomes ambiguous because the words taken literally lead to absurd results." Under the literal meaning of the words used the

contractor was liable to the railroad every time any materials for the project began its journey to the site regardless of the distance from the site.

The liability of the contractor was completely at the mercy of the conduct of others who were acting without the knowledge and control of the contractor. The words of the indemnity taken literally lead to an absurd result which invokes the rules of ambiguity and which allow the court to construe the contract according to the intent of the parties. The only evidence of intent was the testimony of the contractor that the indemnity agreement applies only within the project limits.

Although this ruling was favorable to the contractor in this particular case, it is important to recognize that there is also a descending opinion by a judge in this case. "The indemnity provisions," this judge says, "of the contract herein are not ambiguous on their face and likewise are not ambiguous when applied. Rather than limiting indemnification to the jobsite or to the specific work actually performed on the bridge, the contract by its plain language required that the contractor is to indemnify the railroad for numerous activities including transportation associated with replacement of the bridge regardless of the location of any accident related thereto. To construe the language of the contract otherwise is to rewrite the contract so as to limit indemnity to injuries which occur within the area not set forth in the contract."

What does that mean to everybody? Go get a lawyer? This is why this indemnification was found to be not effective because some lawyer said, "Hey, wait a minute." So do we find a lawyer who can second guess not only what the contractor's lawyers are going to say, but what the insurance company's lawyers are going to say, and the subcontractor's lawyers and the supplier's lawyer and the supplier insurance company's lawyer? How do we get an effective policy and effective program?

What type of additional insured endorsement or additional protective persons endorsement is the best to protect the railroad in terms of an indemnification? In some states, as you may be aware, indemnification will not apply. It is against public policy for an indemnification to apply when you are asking a contractor or another party to indemnify you from your negligence in whole or in part.

There are other policies to buy. There are policies called owners and contractor protective liability. Some say that this particular railroad protective policy, if you purchase one of those has to stem from the contractor's work at the contractor's jobsite as defined in the declaration.

Is it worth one percent? Let's talk about the loss ratios of a railroad protective policy paying out claims.

I talked to one broker in addition to the broker who I use who has a loss ratio of zero in 15 years. On all the money that he has collected on premiums, he has paid no claims. I think he said he paid about $1,500 one time to have a lawyer write a letter saying it is work that was within the contractor's control; therefore go to the contractor's liability policy. One percent of your construction contracts at the end of the year adds up to a lot of money.

The second topic that I am going to discuss is one that becomes a little more sensitive. I was talking with a railroad guy yesterday and he said if I talk about this subject, it is probably not good management of the risk for me to mention a particular railroad who may have been involved in some of the things I am going to talk about. Unless, of course, it's not his railroad. These plans up here that I have on the table represent three of many jobs that we have had the opportunity to work on that were designed by engineers and architects that either required redesign or that was work that was essentially not buildable by plan. I think there has to be some responsibility on the engineering firms of those who design projects as well as contractors who would take this plan. I am going to make an attempt not to show the names on the plans.

Today we have a very tight market of bidding. There is a very high percentage of low

bidders who will look at a plan and look at a project and give a bid and will be low at the beginning of the job. However, by the end of the job they are significantly higher than anybody else that bids the job.

For this particular plan, the engineering firm that designed this had the contractor driving steel sheet piling four feet into solid rock. Now, this was for a major operation. It was for track support while putting in a bridge so that they could allow trains to continue to operate.

I think most of you are experienced enough at railroad construction to know it's pretty hard to drive sheet piling into solid rock. How would you bid the job? Would you expect a contractor to come up and say, "You know, we have a problem with this. We can't do this kind of work. Is there a possibility of getting an addendum out?" Most of the time this isn't likely.

What I am finding is that the preplanning and the bid phase takes a long time. Sometimes it takes a year or more. When it goes out to bid, it may be two weeks or it may be a month for the railroad to say, "Here, you six contractors bid on this." Then when the bids are turned in, there may be a little bit of a lag in decision time. When the contract is finally awarded to whoever, you have to have the job done yesterday.

There are also situations when you want to have the job done yesterday and you also want to have it done under traffic with five trains a day. Something happens between the time the contract was awarded and when the contract is actually being done where you had only five trains a day and now you get 35 because you had a problem with another line down the way. So what does the contractor do? The contractor looks around and thinks this is going to be one good job. You all know it happens.

Not only do I think that architects and engineers need to be more responsible and more accountable, but contractors need to develop. They need to change the reputation that there is in the industry as a whole to try and work with the owners, such as yourselves, to have the owner's best interest in the contractor's minds. I think that if the contractor does that then not only will the owner be happy, but the contractor will make some money. The contractor may not make a killing on that particular job, but he probably will be invited back. He will probably be consulted by the railroad or with the owner to say, "Hey, you have done a good job and not only that, you were fair. You were responsive and you were responsible."

This is a project that amounted to nearly $350,000 on the original design for some sheer fences in the river. The project was designed by an outside engineering firm with, what I feel, some disregard for feasible and efficient construction methods. The project was designed with timber piling, there is nothing wrong with timber, where the contractor was required to dive into the water, drill through the timber piling and install the bolts and the lagging under water.

This was called value engineering. I have some principle problems with value engineering because what happened is the contractor went to the owner and tells him he doesn't want to do this. You don't want to spend $350,000 when this job can be done with a better project with a lot less money. Let's value engineer this. We will give our idea to an engineering firm, probably it will go to the same engineering firm that did it the first time, and they will redesign it according to the way they think it should be built.

What happens is that engineering firm gets paid the second time to do the value engineering. Let's say that cost is $15,000. You add that $15,000 to the original design cost. Then the contractor comes back and says they can do this job for $75,000 less than what the original proposal was. What we would like to do is take that $15,000 off $75,000 and we get a $60,000 savings. We want to do it with your money. We want to split your money and we will take $30,000 and we will give you guys $30,000 because this was our idea. You know what? The railroad really saved $30,000, but I believe that the railroad should have saved $75,000. I don't believe that the engineering firm should have been paid the second time for

doing something that was not feasibly economically buildable and I believe that the contractor should have been working with the owner and the engineering firm either by choice or by force, not the owner but the engineering firm should be consulting with contractors who are experienced in this type of work and ask what is buildable? What is economically buildable? What is feasible to do for this owner? Because if we are to protect the owner's rights and the owner's interests, we also need to look out for the owner's pocketbook. That $75,000 should have gone into the owner's pocket 100 percent. Value engineering should have been done up front.

In this particular case, this value engineering saved almost $62,000 on a $300,000 job. That is 20 percent. That $61,000 doesn't include the cost that was paid to the engineering firm to redesign the job. I have a big problem with that. Now, that's whether it's in-house design or whether it's an out-house design and you all know what I am talking about when I say an out-house design.

Project number three is a building job. The building was designed by an engineering firm who thought about it and said they didn't know if the soil conditions under this building were going to be able to tolerate a standard four-foot footing, four feet deep. So what we will do is make it an eight-foot deep footing because essentially, who cares? What the contractor did, after the job was let and awarded, was go in and say we didn't need to have an eight-foot deep footing. You need to have a four-foot deep footing because all we have to do is take a backhoe out there or a drill truck and drill down eight feet and figure out what kind of soil conditions we have. If the soil conditions are such, maybe you can do an undercut and put in about a foot of gravel. A foot of gravel is a lot less expensive than four feet of concrete and the excavation and backfill required.

This engineering firm said they didn't have the capabilities to go up there and determine what the soil conditions were. We have been in the area and have some experience with that. The soil conditions may not be as good as what they should be and we just decided to cover it. Does a prudent contractor, before the letting, look at this job and say why do you need an eight foot footing? Would they come to the owner independently and say to the owner that they think he could get by with a four-foot footing, but let's do this to keep your costs down. Let's go out there with a backhoe and take a digging and find out what we have for soil conditions and then redesign this plan and make it more efficient? This engineering firm wanted to withdraw its state stamp when they were asked not to do any more work on the job. The proper response is you want us to withdraw your state stamp, that's okay. You give us all the money that we paid you, we will take scissors and we will cut up your state stamp and give it to you. We will get somebody else to stamp it.

I am not saying here that the contractor is always wrong, that the engineering firms are always wrong, and that the owner is always wrong. I am saying that if you have those three parties together when a project is getting ready to be anticipated and you sit down with a reputable, responsible, prudent, and fair contractor and a responsible, reputable, prudent and fair engineering firm along with what everybody thinks they are is a reputable, responsible, prudent and fair owner and negotiate a fair and reasonable contract, you will undoubtedly end up with a higher quality and more economical project.

The days of the low bid actually being the lowest responsible bid are over. The economy, the competitive contractor environment, and the quality of plans and specifications have led to the question of low bid responsibility.

It is very prudent business to locate and utilize a responsible and fair contractor before engaging an engineering firm. This contractor will work with the selected engineering firm to design an efficient and buildable project. You will see your engineering costs and construction costs drop dramatically. You will see your migraine headaches once normally involved in construction be reduced to no pain or to a minor ache.

Internal costs for owners will certainly be reduced with negotiated based contracts. The

bottom line and the reliable way is to be smarter than your competition. The smartest way is the negotiated way.

President Van Huis: Our next presentation is called "Design and Construction of Railroad Facilities Related to Railroad Yard Applications" and our presenter is Mike Boyer. Mike is a native of St. Louis, Missouri, and a resident of Georgia since 1972. He completed his Bachelor of Science and his Master of Science degrees in civil engineering at the University of Missouri in Columbia. He was formerly with Georgia Environmental Protection Division in industrial wastewater regulatory program and emergency respones and also served as regional manager with another national consulting firm.

Mike founded Applied Engineering & Science, Inc., in 1980. He has also managed several hundred railroad environmental and facilities projects including tracks, yards, servicing facilities, and shops across the United States and Canada.

Mike is a registered P.E. in 12 states and a member of AREA Committee 14 and the AAR Environmental Advisory Subcommittee.

Mike is president and CEO of Applied Engineering and Science, Inc., out of Atlanta, Georgia. Please welcome Mike Boyer. (Applause)

DESIGN AND CONSTRUCTION OF ENVIRONMENTAL FACILITIES RELATED TO RAILROAD YARD APPLICATIONS

Mike Boyer

President
Applied Engineering Services, Inc.

Today's railroads are in the midst of a construction boom. This has been fueled by a number of factors, but certainly favorable overall profitability of the rail industry is a major consideration. A significant part of this construction includes new facilities for environmental control as well as other new activities, either whose design and functions are dictated by environmental controls or for which the actual construction have significant environmental concerns.

The railroad bridge and building (B&B) department is a project design and construction arm which classically has been responsible for project implementation. As a result, B&B forces have been developed over time into a flexible, versatile tool for implementing a wide variety of construction projects across the railroad. The structure of the B&B department is changing at virtually all railroads to reflect strategic realignment of services in response to geographical client sector/based internal reorganization and other related factors.

This presentation explores the role of the B&B in environmental projects as well as other projects with environmental issues. The paper addresses worker health and safety issues. Selected unique construction methods are reviewed and some commentaries are also provided with respect to the future of these challenges and this B&B function.

Role and Structure of B&B in Today's Railroad

Yesterday: Twenty years ago and prior, B&B departments were organized and run very similar to a large turnkey/design and construction firm, with one client to service. B&B departments had very significant design engineering and drafting personnel, office and field construction staff as well as construction forces and equipment. Very little if any work was done by outside engineering or contractors, other than occasional major new shops or very unique projects.

The role of B&B was to interface with other railroad departments for project implementation, but B&B usually filled the overall project management role. B&B interfaced with at least three other departments who also had engineering, construction management, and actual field construction forces and equipment. These departments were:

- Mechanical
- Maintenance-of-way/track
- Electrical/signal

Depending on the railroad and the individuals involved, one or more of these functions might actually be organized under B&B. Similarly, B&B might itself be part of a larger Design and Construct engineering department or vice versa.

Today: Clearly the past 20 to 30 years have seen changes in size, organization, and function of the entire railroad industry that even the most pragmatic would not have predicted. The results have been good for the industry as service providers and overall profitability. Today, there are far fewer major railroads and there will undoubtedly be even less ten years from now. The shortlines and regionals have surged in growth, but they are now, also, going through the inevitable consolidation, as shortline holding companies flourish. This has been good for the industry from a shareholder profitability and client service standpoint; however, it has brought about substantial change in the way projects are implemented.

Engineering and construction capabilities which were virtually self sufficient 20 years ago have now been greatly reduced or eliminated entirely. This is not limited to project implementation functions. At least two major railroads have virtually eliminated the materials department.

Today's B&B function is a combination of oversight of outside contractors, along with direct supervision of much smaller wage agreement field construction crews. The size and scope of the remaining implementation functions still varies greatly from one railroad to another, with at least one major "western" road still implementing much of their own construction with B&B and water service forces.

Also, the structure and interface role of B&B has changed. One major eastern railroad has essentially eliminated the traditional B&B function and organization, and has two vertical reporting functions, one for buildings and one for bridges, B or B rather than B&B. Also, functions and interfaces with other departments involved in project implementation are becoming more critical and enhanced. For example, the local roadmaster may be the only person at a remote site who has any construction implementation or management capabilities and he or she may be asked to augment or support B&B and other functions on certain projects and maintenance tasks.

In spite all this, responsibility for all the ultimate goals — getting projects implemented — has not reduced within the B&B/Design and Construct core group. The task is now accomplished with great reliance on outside help for engineering procurement and construction.

In view of this, this presentation will discuss issues which may apply to B&B as well as other departments on the railroad who deal in related project and maintenance activities.

Tomorrow: The downsizing and outsourcing will continue. B&B and other railroad functions will continue to focus on project and program management and the role of developing the details will be left to others outside the railroad. More is said about this a little later on in this presentation.

Clearly all this greatly affects how B&B will handle challenges and problems related to environmental issues.

Environmental Projects

These projects are grouped into three general categories on today's railroad:

- Wastewater/contaminated storm water treatment
- Rainfall runoff and wastewater collection
- Contaminated groundwater extraction and treatment

A fourth category is actual water supply treatment systems, however these are rapidly disappearing and are not discussed further.

Wastewater Treatment Facilities

Railroad operations, particularly through locomotive and car servicing and maintenance activities, generate significant quantities of wastewater. Rainfall runoff from certain outdoor areas, such as open locomotive servicing platforms, is also collected, treated, and discharged. Railroads have been in the business of designing, constructing and operating such facilities since about 1970, although several railroad wastewater facilities certainly predate that time.

These facilities can range from a simple gravity oil-water separator to sophisticated physical-chemical facilities costing several millions of dollars. Design of these facilities is often directed through a railroad environmental engineering function working in conjunction with B&B and other railroad functions. Construction requires a mixture of site work, concrete, mechanical, electrical, and sometimes a building enclosure.

The civil works portion of the construction, which traditionally B&B has addressed, can be substantial. These facilities often require deep subsurface excavation for sewer work and construction of below-grade vessels. A substantial amount of cast-in-place reinforced concrete is required, with significant water tight requirements. This may involve extensive water stop placement. Although this should be a design specification issue, not all commercially available water stop materials are acceptable for the petroleum products which are encountered in railroad wastewater applications. The concrete work includes cast-in-place and composite elevated decks.

Subsurface problems are also a significant problem. These can be due to rock, unstable sands around open excavation, high groundwater, unsuitable clays, et cetera. While these items should be addressed in the design phase, unforeseen situations which must be dealt with on the spot are common.

The wastewater facilities are often associated with new or expanded locomotive servicing and maintenance facilities. The construction type and mix is similar, with the exception of the deep excavations required for wastewater.

Collection Systems

Gathering up the correct wastewater and potentially contaminated stormwater streams and transferring them to the headworks of wastewater treatment facility is usually a significant portion of the project. As anyone who has ever tried knows, constructing new below-ground sewer lines across and around active operations in an old rail yard is a real treat.

Train traffic will always have priority. Deeper trench excavations are subject to substantial static and dynamic loadings due to traffic and create a need for greater concern and measures to protect against cave-ins. Pump stations and other below-ground structures can also be subject to unusually high lateral soil pressure loadings.

Three mediums are normally employed to collect potentially contaminated rainfall for conveyance in the collector piping:

1. Rail collector pans
2. Concrete aprons
3. Membrane liner system

Each system has its advantages and disadvantages with respect to costs, specific

applications and related considerations. Our experience indicates that all three are acceptable in various applications when designed and constructed correctly. The selection usually becomes a matter of personal choice with the railroad engineer making the selection. A fourth system is comprised of an oil absorbing mat material rolled out on tracks in areas of chronic spillage.

The liner systems are probably the most misunderstood but possibly the best approach to containment, if used correctly. Most liner systems which are now installed for environmental containment applications are high density polyethylene (HDPE). They are used as either a primary or secondary containment; however, the difference is usually immaterial relative to the design and construction. It is absolutely essential that each application, including the details, be well thought out during the design stage and that the system be constructed in accordance with the design.

Prefabricated pans, designed to fit modern rail gauge and applications are available in carbon steel, stainless steel, fiberglass reinforced plastic (FRP) and thin-walled pre-cast concrete. Of these, the carbon steel has the widest use in the rail industry. The pan systems are relatively easy to install on tangent track which is in moderate to good condition. Steel pans can be installed on modest curvature with field cutting and placing. Prefabricated pans are available to fit curved track of a defined radius; however, the expense is quite high and they rarely fit as planned.

Reinforced, cast-in-place concrete is the tried and true material of choice for containment aprons. The cost for concrete systems, with anchor bolts, transition slabs, et cetera, is two to three times greater than pan or liner systems. In some cases it is justified, and in others it clearly is not. Larger locomotive servicing and ready track areas often employ a combination of two or more methods to focus on the best approach for the least cost.

Groundwater Contamination

Although somewhat new on the scene, these facilities now probably account for more capital dollar expenditures than wastewater handling systems. Many railroad groundwater contamination problems are located in and around old shops and locomotive servicing points. At these locations, it is often convenient to treat and sometimes collect groundwater through an existing wastewater facility which serves those shops' facilities. In some instances, such as derailment sites, leased properties, et cetera, an entirely new facility may be required. Some or all of this construction task may fall on B&B.

Collection of groundwater from shallow contaminated aquifers is often accomplished through a series of interceptor trenches, slurry off walls and related subterranean methods. B&B may become involved in project management or actual construction of these facilities.

These groundwater recovery and treatment facilities experience many of the same problems and challenges associated with traditional wastewater collection and treatment, including deep excavations, live track lateral loadings, and related considerations.

Environmental/Safety Considerations

Railroads face substantial challenges in dealing with potentially contaminated soil and groundwater, both at their yards and terminals, as well as from off site and leased property situations. These conditions can represent unknown and unanticipated conditions to the B&B construction crew for potentially any construction project on railroad property. It is not uncommon for subsurface construction in shop and servicing areas to encounter soil and/or groundwater contaminated with petroleum product. In some cases, the contamination can also include hazardous or toxic constituents. Certain materials may have been buried on site due to past operations. This could include drums, old munitions, batteries, et cetera.

Those conditions can represent a worker safety issue if not properly dealt with. Further, simply working around some of these hazardous materials requires special OSHA required training. Few B&B construction crews have this training; however, the B&B superintendent needs to have adequate training and knowledge to recognize these situations and react accordingly.

Further frustration will occur when a construction site is shut down because the B&B work crew was removed due to encountering an unknown situation which may represent an unsafe or hazardous environment. This can apply not only to B&B forces, but also to outside contractors who may be working under the direction or responsibility of the B&B superintendent.

Much of this can be prevented by up-front planning and coordination. Initial meetings with railroad environmental personnel and local forces should allow the project team to define known or suspected problems in the area of the proposed construction and take action in advance. For example, a project involving a rebuild of a locomotive servicing platform and inspection pits in the same location can reasonably expect to encounter soil and groundwater containing petroleum contamination. A suitable investigation should be conducted to define the extent of the contamination in advance of the construction. Dealing with the excavation, removal and disposal of this contaminated material can then become a scheduled part of the entire construction effort and projected budget. This activity should also include appropriate time and resources for dealing with state and local environmental regulatory agencies.

Selected Design and Construction Issues

This section reviews selected areas which either impact environmental construction or have environmental impacts on other projects. The comments and suggestions generally reflect the experience of the authors; however, each situation should be evaluated on its own merits.

1. **Cast-in-place versus precast concrete:** Railroads make frequent use of precast concrete for construction needs. Precast has it applications but it is not universally recommended for environmental projects. Precast is a good choice for manholes, small pump stations and effluent monitoring stations in some cases. Precast is not a desirable alternative to cast-in-place concrete for oil separators, grit chambers and load bearing vessels. Attempts to use precast concrete for such applications represent an effort to modify someone's standard precast product in order to make something similar to what is desired. Cast-in-place concrete can be used to obtain precisely what is needed.

In these applications, cast-in-place concrete is comparable in total installed cost. Precast concrete generally does not weather as well. It is more inclined to leak and may be structurally unsuitable in external loading situations encountered in yard applications.

2. **Pipe casings:** Collection systems installed invariably require numerous below grade track crossings. Railroads have historically required the use of casing pipes beneath rail lines. With the use of present day superior pipe construction materials, this is not necessary. For example, if a short run of eight-inch drain pipe is required beneath a track, rather than use PVC pipe with a steel casing pipe, a less expensive alternate is to use ductile iron pipe, which requires no casing pipe for loading and will probably outlast the track. We specify galvanized steel for piping three inches in diameter and less, and ductile iron for four inches and larger beneath track, without casing pipes.
3. **Concrete aprons:** Concrete is a very desirable medium for spill and runoff containment in servicing platforms, truck unloading pads and related areas. Such systems must be designed and constructed by taking up the old track, properly preparing the foundation soil base and relaying rail, properly anchored into the new slab with neoprene pads. In addition, transition slabs are highly recommended.

Short cuts using concrete simply will not last. Concrete cannot be poured over existing wood ties and around rails. Slab thicknesses cannot be compromised. The neoprene pads or suitable alternate cannot be done without. Concrete aprons and surfaces require protective coatings on fuel aprons and areas where corrosive materials are stored. Concrete done well

will last a long time. Concrete done poorly will crack and fail quickly and under active loading conditions.

4. **Liner systems:** HDPE liner systems make an excellent spill containment/runoff collection medium, if they are designed and installed properly. Each application must be evaluated on its own merits and maximum consideration must be given to how the liner will be installed. Effective liner installation requires tie off of the liner to a concrete grade beam or similar means. This wall needs to withstand lateral soil pressure during track and liner construction. The cost of concrete can be a major factor in total system cost. End dams must also be tied off. We have used "floating" ties successfully for this purpose.
5. **Sliplining pipe:** This method has been recognized for years as a cost-effective method for dealing with pipe line infiltration. This excessive flow or leakage can be a problem for environmental projects where discharge limitations to a city sewer system are concerned and, in any case, represent additional flows that do not need to be collected or tested.

The use of sliplining in rail yards can have a number of advantages when compared to excavations and replacement of aging underground pipe lines.

1. Track remains open to rail traffic.
2. Up to 600 feet of pipe can be repaired at each set up.
3. Rail yards typically have few service connections to excavate and reconnect.
4. Polyethylene joints are fused together eliminating leakage.
5. Overall service is quickly restored.

Bridges, Et Cetera

Much of this presentation addresses buildings and utilities. Bridges and other structures also present environmental challenges to the B&B staff. A few examples are provided:

- Bridge maintenance, in particular sand blasting and repainting over water, has become a significant environmental issue in recent years.
- B&B equipment maintenance produces wastewaters, waste oils, and other materials which must be properly disposed of.
- B&B crews use a variety of paint, adhesives, cleaners and other construction products. Some of these materials are hazardous to the environment and many can represent employee safety hazards if used improperly. Unused product and spent containers must be properly handled and disposed of. Most major railroads have policies and procedures to deal with this; however advice and direction can be sought from the appropriate company environmental officers, as well as outside consultants.
- B&B crews often encounter asbestos in old buildings and pipelines. Special regulations cover the handling and disposal of this material as well.
- B&B remote work crew trains generate domestic wastewater, sewage. This material can no longer be dumped along the right-of-way and provisions need to be in place to deal with these wastes. This applies to garbage and other solid waste as well.

The Future

B&B staff size will continue to shrink across the board as geographic territory coverage increases. B&B supervisors will still be the key people in managing and directing projects. In certain select areas, railroads will determine that they have overdone the downsizing and staff increases will occur, but this will be the unique exception.

The B&B/Design and Construct function have now become project managers. This may continue to develop to a point where they are program managers, with the project management functions outsourced. In the midst of all this, the B&B staff will constantly be challenged to deal with every day issues in a manner consistent with company policy.

Contractors and Engineers

Although a little of the central theme, the final section offers insight into dealing effectively with outside service suppliers. The B&B/Design and Construct function is rapidly coming to grips with the reality that it cannot possibly perform its mandated project function without outside help. This assistance is available from a large number of engineers, consultants, and contractors across the nation and internationally.

Although railroads have always used consultants and contractors on a limited basis, the industry generally did not have a good experience base for working with outside suppliers on a wholesale basis prior to about 1980. As a result, there were few consulting engineers and contractors who had experience in dealing with railroad problems and needs.

This has changed substantially over the past 10 to 15 years. Railroads have created an enormous demand for outside services for environmental projects as well as traditional construction. The service industry, in a typical capitalistic fashion, has met the challenge. Now a wide range of capable and experienced services can be had in environmental and facilities area.

Several points are emphasized which reflect the author's experience in making the process desirable and cost effective for all parties:

1. You get what you pay for. The client will obtain more cooperation, better performance and the most for their money if project scopes and fees are negotiated with both consultants and contractors. Low bid selection is an archaic, inefficient method for acquiring services. It creates distrust and works against service supplier loyalty. Establish a group of prequalified service suppliers to work with, and select the best suppliers from that pool for a given project. The inherent competition with the supplier group will foster necessary price and quality competition.
2. Get consultants and contractors involved in the project planning as early in the process as possible. The cost of this involvement is usually very nominal for large projects and sometimes free if the supplier is pre-selected. It creates a much larger base for project development experience and value engineering.
3. Arrange your time as well as the service supplier's time to review multiple projects during organized meetings. Conversely, whenever possible, forget the meeting altogether and use conference calls when practical. The consultants and contractor personnel do not want to travel any more than you do.
4. Be flexible, particularly during times of design changes and construction change orders. Few, if any, projects go exactly as planned. Often changes are due to entirely unforeseen conditions on everyone's part. Hard line positions on either side creates distrust and will get nothing accomplished. Virtually everybody wants to do what is right and be treated fairly under these conditions.
5. When a service supply company does a good job, tell them so. Letters of congratulations and recommendations are highly prized trophies in the service industry and are very greatly appreciated.
6. Conversely, virtually all suppliers want to know when a client is not happy with performance. It is never a fun task, but a frank discussion to air views will often bring issues to light that were unknown by both parties and will certainly go a long way to increase trust and respect.
7. When taking multiple proposal/bids, advise the losers as soon as possible, not next month, not when the project is over, and not when you finally get around to it. Contractors and consultants are constantly reevaluating their backlog and workloads. Unknown status of outstanding proposals is extremely disruptive to the business planning process. This represents another method to foster mutual respect and trust.
8. Avoid taking proposal/bids on projects that the railroad does not fully intend to implement. This is considered a major waste of money by the companies proposing and always leaves a bitter taste.

Thank you very much. (Applause)

President Van Huis: That was a great presentation. Again, thank you, Mike.

Our next presentation will be entitled "Working Safely With Lead" and the presenter will be Bob Sims from the Burlington Northern.

Bob began his railroad career with the Burlington Northern in 1976 working in the bridge department. In 1982, he accepted the position of system steel bridge gang foreman and subsequently was promoted to supervisor B&B headquartered in Galesburg, Illinois, in 1988.

Bob's innovative approach to work site and personal safety lead to the design implementation of fall protection measures incorporated on Burlington Northern bridge gang boom trucks. As a result, Bob's territory has had the best safety record in the Burlington Northern B&B department for the last three years which is not exactly a small feat considering that they were pretty much responsible for rebuilding the Burlington Northern during and after the Mississippi River floods in 1993. Bob has received tremendous accolades for his efforts.

He also has been very instrumental in lead awareness and abatement training in the Burlington Northern and hopefully now will share some of his insights with us.

WORKING SAFELY WITH LEAD

Bob Sims

B&B Supervisor
Burlington Northern

Good morning. During the next few minutes, I would like to share with you some of the ways that the Burlington Northern Railroad is working safely with lead. There are many different interpretations of the regulations for working with lead and I hope this presentation will demonstrate the need for you to know and understand those regulations. My intention here is to simply show you some of the work practices that Burlington Northern has put in place to satisfy those regulations and, more importantly, create a safer work environment for our employees.

On June 3, 1993, the scope and work practices for railroad and construction employees exposed to lead changed dramatically. That is the date that OSHA's new standard 29 CFR 1926.62 became effective. The standards extend to all lead-exposed workers, not just those removing lead-based paints. Construction workers are defined in the standards as workers involved in construction, alteration, repairs, painting, or decorating, whether it be buildings, bridges, or any other structure that may contain lead-based paints.

Predecessor railroads of the Burlington Northern were known to use up to 40 pounds of red lead primer for a five-gallon bucket of paint. Even though we have not repainted any of our bridge structures since the early 1980s, the old paint and residue is still on the bridges. OSHA has determined that any worker performing any job task that will disturb this paint or residue could be exposing themselves to an unacceptable amount of lead.

There are two routes of entry for lead into our body: inhalation and ingestion, which basically means we are either going to breathe it or we are going to eat it. The standard states the permissible exposure limit for lead is 50 micrograms per cubic meter of air.

Now to put those in terms that you and I can relate to a little better, compare it to Arrowhead Stadium in Kansas City, Missouri. It holds a little over 75,000 football fans. If we had a standard piece of blackboard chalk composed entirely of lead, pulverized it, and it

became airborne, if the air currents were just right, everyone in that stadium could be exposed to the lead content above the permissible exposure limit.

Now to prevent that, the standard also has an action level of 30 micrograms per cubic meter of air. Basically all this does is the standard goes into affect when you reach this level of exposure to prevent you from exposing your employees to the permissible exposure of 50.

The method most often used to determine your exposures is air monitoring. You can see this very well. This is a small air monitor hanging on the side of a bridge. It is a basic, simple instrument. It is a small, battery-operated air suction pump inside a small black box attached to a three or four-foot rubber hose with a plastic capsule on the end of it with an paper filter inside. It sits there all day, bringing in the air and any contaminants in the area. This is how we determine what our restricted area or work area is going to be.

Not only do we air monitor for an area, but we also air monitor the job task that the men do. We have air monitored every task whether it be an air impact tightening hardware causing vibrations on the steel or by welding, cutting, or rivet cutting.

On this air monitor, the filter is here and here is the breathing zone of the employee. That is where the standards come up with this cubic meter of air. They have determined that is where we breathe our air, in the cubic meter that is around our head.

It takes approximately a minimum of five days to receive any results from your air monitoring. In the meantime, OSHA has a table of the standards that has three levels of exposure. The 50 to 500 micrograms and a job task in that would be manual scraping of paint, whether it is in a depot or on a bridge, or doing water surface repair sweatfitting a water pipe.

The second level, 500 to 2,500 micrograms would be basically air tools, impact wrenches, steel guns, or rivet cutters where you are creating quite a bit of vibration or also creating air currents that are going to blow the residue or slough off the bridge.

The third level of exposure is greater than 2,500 micrograms. When you get into this level, you are doing cutting with a torch, welding, or sandblasting to remove the paint. When you get over the 2,500 exposure limit, you are getting into the Cadillac of protective equipment.

Like I said, it takes five days to receive your air monitoring results. To compare some of Burlington Northern's air sampling results to OSHA's tables, this gentleman is using a CP11X rivet cutter. OSHA's table says we are going to be in the 500 to 2,500 range for exposure. Burlington Northern has done 46 samples and our exposures were .57 up to 293. So we are quite a bit lower than what OSHA table says you are going to be doing those job tasks, but we are still over the permissible exposure limit of 50.

Their third range of the table is greater than 2,500. We have done 98 samples in that area with welding and cutting torches and we have had exposures of .72 up to 1,300 micrograms. Again, well over the exposure limits, but well under what OSHA's table says we are going to find.

Now in their first category, the 5 to 500 level, we have basically used that for our helpers and the men who work around the perimeter of the jobsite itself going after tools and supplies and equipment as the job progresses. We have found that if we can keep our restricted area small enough, our helpers and the men around the work area for those 19 samples, we only found an exposure limit of less than 11 micrograms. So we can cut back on quite a bit of the protective equipment on the work practices.

You can see the man here has a respirator on. The two gentlemen on the bridge deck itself above the ties do not. It is a lot safer for these employees because when you wear those face masks, as you all know, you lose peripheral vision and just being able to see when you walk.

Responsibilities for providing a safe working environment for employees are multiple and varied. On the Burlington Northern, we use a team concept to fulfill these responsibilities, upper management who approves the required funding, our industrial hygiene and chemical, which developed the lead core program oversees the air monitoring

and the medical surveillance, and the B&B manager, the frontline supervisor, who implements the plan and oversee the training.

However, the actual implementation of the program begins with our foreman or crew members. One of the major responsibilities at the jobsite, the first one, is to make sure that the standard is displayed. That means the company training program and the lead program are displayed and any historical data that we need picked up for our air monitoring results.

The Burlington Northern program outlines three methods for controlling lead exposure. The first one is administrative controls; we take the employee away from the lead. The second is engineering controls; we take lead away from the employee. Finally, work practice personal protective equipment controls which is where we protect the employee in the presence of lead.

Separating certain work activities and worker rotation are examples of administrative controls. When a man is using a torch doing any welding, you can see all the smoke and fumes around the man. He himself will be there by himself or only one other employee will be there working with him and that keeps the exposure levels down for the crew members because they are not involved in that job process and they are out of the work area itself.

Worker rotation under extreme heat or extreme cold just helps the employee to either walk away from the work area and cool off or warm up depending on the temperature constraints.

Engineering controls with experiments is the chemical paint stripper and this is basically where you apply the paint stripper to the steel, allow it to drain, and then you manually scrape it. You must capture the residue that comes off. We have found this process to be little time consuming and very labor intensive.

A control that we just tried within the last month is encapsulation.

Here the steel looks like it has been painted. Well, basically it has been. Compare it to painting your home. It's a really thick water-based latex paint applied with an airless sprayer. It has to be applied basically like you were painting your home. The temperature has to be above 50 degrees with the steel relatively clean and dry. The results from that right now on the second level of exposure that OSHA has said 500 to 2,500, we found in our first preliminary tries that our exposures were well below that. We are hoping with further testing that we will be down below the permissible exposure limits on that second level using rivet cutters and backing out.

Doing the torching, it is not helping us much. Common sense is going to dictate that when you fire up a torch and put a fire against the steel, you are going to still be burning the paint. Therefore, you are still going to have the fumes and the smoke to deal with.

Another engineering control is local exhaust. This is basically a 12-inch flexible hose and the welder is doing some work right inside the connection. This hose is connected to an exhaust fan and we are blowing the smoke and the fumes into a neutral area and keeping the exposure limits down for him.

In a restricted area we have the same exhaust fan, but we are underneath the bridge deck working on the connections that small we have a small six inch hose. We lose some smoke up through the ties and through the bridge deck, but it definitely helps in keeping his exposure limits down quite a bit more than if we weren't using any engineering controls at all. Sometimes just a large fan will do the job if you have the work area large enough with a good work platform.

A good example and engineering control like this is have a welder working without an engineering control. All he has is personal protective equipment. I would like you to notice the smoke that is around the arc and the stick. A moment later we turn the fan on and you will notice the absence of the smoke. I want to emphasize that working using an engineering control like that you have to make sure that where you are blowing the fumes of smoke you are not going to contaminate your crew members who are working further down the bridge or at some other location.

Another engineering control we have tried is shrouded tools and that's a needle gun that we are using there. Basically we have a small area we are working in to make a connection and you notice the hose coming off the needle gun. It is removing paint, rust, and residue from the bridge. Well, this hose is attached to a HEPAF filtered vacuum cleaner. HEPAF is a Highly Efficient Particulate Air Filter and it is basically just a big shop vac, only what you are pulling in through this vacuum is not being discharged back out into the environment. We use this tool also for the EPA and DNR regulations that we encounter.

This is what we use to vacuum some of the larger paint chips off the side of the bridge, the scaffolding, or the work platform that we build on the bridge to keep from just blowing them off or washing them off into the creeks or onto the grounds.

Administrative or engineering controls would usually not be enough to provide a safe working environment for the employee. It will almost always be necessary to utilize work practices, controls, and personal protective equipment.

Personal hygiene is very important in this step of the program. It was stated earlier that one of the reasons for air monitoring was to identify the restricted area or work area. You have to place signs where that restricted area is so you can do the proper controls before entering the restricted area. The consumption or presence of food, beverages, or tobacco products are prohibited inside the restricted area. Therefore to help the men, we basically built a really simple wooden work den for them to keep personal items in. While they were outside of the work area, they could store some of the their personal protective equipment in it. If nothing else, it's a good housekeeping control to keep the equipment, lunch boxes, respirators, hardhats, or whatever else from laying on the sidewalk and being stepped on or tripped over.

While in a restricted area, the Burlington Northern has adapted one policy during high temperatures and heat when dealing with the heat stress. Under very rigid controls, we do allow our people to have water inside the restricted area.

This employee is being handed a sealed bottle of water that we have available on our company. That employee will break the seal and drink the water. If he does not consume it all, he pours it out and then disposes of the container properly. But while we are in the process of him getting a drink of water, there is no major work going on that will cause an air contamination problem.

Upon leaving a restricted area, all employees are required to wash their faces and hands and, if feasible, take showers at the end of the work shift. On this particular job we were able to have a decontamination trailer on site. It worked very simply. The men at the end of the day go in one end of the trailer, remove their dirty clothes, step into a shower, wash up, and then step out the other side of the shower at the other end of the trailer which is called the clean area. So you have the dirty area on the one end, the showers, and then the clean area.

Now, when they are breaking for lunch they are not going to be taking their showers. If you will notice the door over the tires on this trailer, this is an outside accessible hand and face washing station because they still have to do that when they break. If it is not feasible to have a wash station decontamination trailer on site, you are still required to have the men wash their faces and hands upon leaving the restricted area.

This is a very portable plastic wash station. It has a foot pump at the bottom and a spigot at the top. It is very handy and portable and you can take it right out to the edge of the jobsite so when the men walk out of the area they can wash up. This can be used even in extremely cold weather. You just put some RV antifreeze in with your water.

Most of our crews carry eye wash stations in case an incident happens. They will even work under certain circumstances for a hand and face wash station.

The standard states that it is the employer's responsibility to provide the employees with the required protective clothing. We use basically two types on the Burlington Northern. This type is a tie back fireproof disposable coverall and hood. These have to be removed and

disposed of properly at the end of the shift or if they are torn during the shift. The men wear these in colder weather because we buy them extra large and they can put their insulated coverall or layered clothing underneath to stay warm. They also use them for jobs of short duration whether it's going to be a day or just a few hours or several days. It's still easier and cheaper to use.

For jobs of long duration or in extremely warm weather, the men prefer a launderable fireproof coverall and fireproof hood. They are much more comfortable and a lot cooler. They can also take them to a licensed laundromat. In order to launder, you have to give written information to the laundromat that they may be dealing with lead contaminated clothing.

When the employees leave the restricted area and wash their launderable coveralls, personal hygiene is still very important. They also vacuum the residue and paint that may be on their coveralls. This is a much smaller HEPAF filtered vacuum cleaner. It is similar to shop vacs.

Working the restricted area also requires respiratory protection. This is the most commonly used respirator in ballast work. It is called the negative pressure air purifying half mask. We also use a tight fitting respirator commonly called a PAPR which stand for Powered Air Purifying Respirator. Our welders usually use the Powered Air Purifying loose fitting helmet that replaces the welding helmet or hard hat and safety glasses. It is powered air that keeps blowing around their face and heads. It also keeps them a little cooler during hot whether.

All contaminated refuse must be stored in a suitable container or bag and kept until it is determined whether it's a hazardous waste. This would include the filters that you take out of your vacuum cleaners, disposable coveralls, respirator filters, or any cleaning materials that you might have used.

This is not an astronaut. This is the Burlington Northern employee properly outfitted to perform steel repairs in a lead environment. Most of the tools and equipment available to aid us as we attempt to work safely with lead have been developed for the paint industry. We have had suggestions from the workers who use these tools and they have said that we should try to come up with some hydraulic rivet shears, hydraulic punches or torches, and built-in exhaust systems.

Our challenge is to convince the research and development departments of manufacturers that there is a market and a need for tools in the steel repair business in a lead environment. We will only be able to meet this challenge if we work together. Working together is basically what this conference is about.

This concludes my presentation. Thank you. (Applause)

President Van Huis: That was a tremendous presentation. Thank you, Bob.

That concludes the joint session for this morning. B&B will meet across the hall in 15 minutes. Roadmasters will re-convene in this room.

(Recess)

BRIDGE AND BUILDING
TUESDAY MORNING SESSION
September 26, 1995

Mr. Lileikis: The first presentation of our B&B session will be given by Rick Briggs and is entitled KCS Bridge Rehabilitation.

Rick started with the Kansas City Southern in 1981 as an assistant engineer doing what assistant engineers do best, field engineering. He has worked with track geometry and did design some plans and mapping work for the KCS. He moved to work on bridge projects in 1987 as project engineer working for the bridge engineer doing coordination of bridge projects, bridge surveys, plans for bridge replacement and grades, working with infrastructure, and bridge structure.

Rick was given additional duties when they picked up the Mid-South. He has an office in Shreveport and works on a 2,800 mile railroad system.

Please join me in welcoming Rick Briggs. (Applause)

KCS BRIDGE REHABILITATION

Rick Briggs
Project Engineer
Kansas City Southern

What I would like to tell you about is the rehabilitation that we normally do with the KCS on some of our lighter to medium density traffic lines.

What we look at when changing the upgrading are open deck timber trestles. We have made a decision to go with steel stringer beams to replace the timber cords and stringers that we are now using. The type of construction that we use is this sort of work.

Here we reuse the existing timber piles and place new concrete taps on the timber piling. To this, we replaced the timber cords and stringers with steel beam sections and then a new or reused deck panel is placed on top of the beam sets.

As all of you know, the size of the structural timbers of our bridges is pretty substantial so we have experienced a lack of good quality lumber of a sufficient size to replace some of our structural members. Another thing we have seen is that the new fast growth lumber is not of sufficient quality or is as good a quality as the old lumber from when we first built some of our structures.

When we looked at some of our replacement members, we noticed that they deteriorated rapidly. We have seen sheer cracks in some of our new timber stringers that we placed in the ten bridges.

We do operate our own treating plant. Whenever large timber pieces are required for replacement, the lead time is substantial to get the new timbers. Whenever we place an order

for these timbers, it takes about three or four months just to purchase the timber and get it to the location after the timber is purchased. If it is purchased green, there's about seven months of curing time required. That's just to have the timber ready for treating. The timber must be cured for seven months and we can have it treated in about a week. That leaves you with about eight or nine months to get a piece of timber to replace some timber that is bad in one of our structures.

Most of you guys are in the same predicament. Axle loads and train loading has become heavier and heavier on the bridges. These bridges react under these heavy loads and they move. The timber cords and stringers deflect quite a bit. We have experienced some of our stringers cutting in and the cords and stringers cut in over the caps as much as three our four inches. Whenever that happens, you have to replace the timber member. You have to cut into the new timber to match the old that is still good. When you do that, you do away with the treat that you have done to the cap and you have to field treat the member to keep it from rotting. That is the same problem that everyone has.

Another thing that we do is replace our timber caps. We don't replace timber caps with timber caps on our railroad anymore. Whenever a timber cap is found to be in need of replacement, we replace it with a concrete cap. The concrete cap offers much better load distribution. The timber caps suffer from the general problems that timber does. You will have a pile bunch up into the bottom of one or have one crush at a different location. That doesn't do anything for your bridge movement. Whenever a bridge comes under load it moves around a lot. Whenever you go into bridge and have to replace some of the timber members in it, there is a labor intensive process. You have a lot of framing work to do just to replace some of the old timber pieces that are in the bridge.

The traffic on our railroad has become more time sensitive and we have more trains on our system. Over the past two years, the number of trains on our system has greatly increased.

Our normal cross-section for our timber stringer is 8 by 16. That is our standard size of material. They are generally between 24 and 28 feet. The stringers in our existing cords are lapped at every other bend. If you had to change out an interior stringer you would have to dismantle the bridge pretty much to change a stringer that is in one of our cords.

We have some pumper stringers that are applied on this bridge. That's where we have had a deteriorated stringer, one that is rotting or having some other problem with the bridge there. These stringers are used temporarily just to help out until we get this bridge replaced or rehabilitated.

We reuse our timber piles on this type of rehabilitation. The old caps are taken off and the new concrete caps are placed on the bridge. They are bolted back with the cross bracing to the piling and used like the timber cap. However, the benefit we have here is we don't have any pile driving to do for these bridges.

If you look down in the water, you can see that we have a cutoff piling. A lot of our bridges are now third or fourth generation. There is not a whole lot of room left to drive the piling in some of our old bridges.

This is a picture of pile restoration. We decided to restore this pile instead of replacing it so we cut out a section and replaced a new piece of timber into the bridge and epoxy grouted the new piece of timber into the pile and banned it. This works very well for a lot of our bridges. It is a good repair for a piling.

We also believe in treating our piling. We have our bridges cruised and checked for rocks and voids. The pilings are a major concern in our treating program.

In this picture you can see an old bent location and the old cut off piece of piling sticking up. This is a picture of a posted pile. Many times we use this type of procedure to restore a pile to usefulness. This pile had some rot in it or was failing down near the ground line. What we have our gangs do is dig the pile down into the ground where you still have 50 to 90

percent of your pile in good condition. We dig down to where the pile is still good, cut it off, and then cut a new piece of pile to post into the new location. The method we use is we drip a pile on into the cap and then we pin the pile to the stump.

This is a piece of corrugated pipe that we have used as a form. The form is filled with concrete to form a collar at the splice location. One of the major reasons for making the decision to rehabilitate some of these bridges on our medium to light density lines is the cost of replacement.

This is a bridge at Katto Lake that we have replaced.

This is the same bridge, but it has been replaced. We replace our bridge major structures with concrete ballast deck and ballast deck bridges. The cost of this type of construction for us is between $1,500 and $2,000 a foot.

This is another picture of a bridge over a river crossing. This is one of our main types of construction. We use drill shafts as one of our major substructure components in our new bridges. Notice that this is a key girder type construction.

Here is another bridge that we use as one of our standards. This bridge was built on steel H piling. The caps are precast concrete and they are placed into the bridge and welded to the piling. These are 24-foot concrete slabs.

That is another source for our superstructure. The slab is shallower than the T girder so that way we can achieve a better and larger opening under the bridge or we can't use the T girder.

We also use other methods. This is a prestressed box girder bridge. This one has a T girder approach on it.

This is another bridge and this one has the ash toe girders with concrete ballast deck. This substructure on this bridge is 24-inch pipe piling.

This is another bridge that we put in. This is a beam span with a concrete ballast deck. It has 28-foot concrete approaches and it is also built on steel H piling. The piers are decorative face concrete type stone. They are interlocking devices. This bridge was built into a golf course where a contractor wanted it to look nice, so he covered the upper pilings. With this type of construction, the cost is pretty substantial. A lot of these bridges are fairly new so we do have a program of replacing our bridges that are in need of replacement.

Our system is a 2,800 mile railroad. We have 35 miles of timber bridges at present. You can see from our location we are in a high decay zone for timber. The cost of replacing a bridge includes a lot of time as well as money to replace bridges of any size.

This is a bridge over the Black River on the new line in Mississippi.

This is another picture of the approach to the bridge. You can see the connection with the existing concrete arms. This bridge was built with ash toe or Texas type C girders. They were prefabricated with two beams and a concrete ballast deck and we set them in half spans.

An alternative to using the steel stringers is some laminated type construction. We don't have any suppliers of laminates on our system so the cost of delivery of the materials would preclude us using them. Being a railroad, you hate to pay someone else to ship something when you are in the shipping business so the cost would rise on this type of construction.

Also if you replace the timbers with laminated pieces, you still get the flex on the laminated pieces as you would on the timber.

Another concern of replacing timber with timber is fire. Fire can destroy a timber bridge in no time. We have heard of some concerns over the fireproofing that is available on some of the laminated structures. The concerns were that the fireproofing may harm the glue in the laminate.

These are some of our beam sets. This is an alternative that we have come up with. We believe they are very cost effective and a good alternative to replacing the timber with our timber. We have got many suppliers on our system of beams such as these.

You can see these are stacked in our own KCS gondola cars and fit quite well in there.

We have two beam sets stacked into each gondola. It makes them easy to ship and you don't have to do a lot of tying and preparation.

Our beam sets cover four spans of timber. Each beam set rest on five of the bents at once. The beam sets can be set normally in about a four-hour work window. That includes all the closing up and the train traffic at the end of the day.

One of the other things we look at whenever we get ready to change out one of these bridges is the track that is on it. What we have been doing to change these stringers spans is cut the rail. Now, for welded rail that is a drawback to these, but with high quality of the field welds, our railroad feels that the tradeoff is worth the cutting of the rail.

Our steel stringer bridges deflect very little under train loads. But another consideration we are looking at now is concrete slabs for this replacement. The concrete slab would allow us to go to a concrete slab structure. When we first started this in 1987 we did not look at the concrete slabs as a replacement.

The locations of these beams is our first concern. We look at low to mean traffic density lines and we look at upgrading the existing open deck bridge. The open deck structure is where all these applications are used. The other things we look at are the bents, the piling on the bents, and the history to see if there is any settling going on or movement of the bents. We also look at the pile condition. The piles must be in reasonably good condition. Generally, we look at bridges that are less than 15 feet tall for this type of construction. That height of bridge works very well with this type of application. The another thing we look at is drift. If the bridge has a history of a drift problem, you don't want to leave this many bents in the channel. We have had some problems with some draft. We have one bridge where we had to put in a long span to move the drift along because the drift was costing us $30,000 a year to remove.

After we have addressed the bent situation, we install concrete caps on the existing piling. The thing we have to do when we install these caps is ensure the level across the caps. If the caps are level and steel stringers work very well, you don't have any edge bearing. They are easy to shim, and that kind of thing.

Another problem you may run into are skewed bents. This is a double-capped bent. Probably the bent is double capped because the track raises. You can either have a large shim in the cap or a timber cap or something like that, but if the track raises in spots is good reason for double capping the bridge.

The next thing we have to do is we have to look at the deck panel. When we look at deck panels, we look at the tie condition to see if the deck pile needs to be replaced. If the survey indicates that the deck panel is in poor condition, we will replace the deck panel with a prefabricated panel. Then we will bring the beam out and set to place on top of the steel shim plates with our locomotive crane.

On our medium and light density lines, we don't have as much traffic as we do on some of our heavier lines so you may end up with larger work limits of six to eight hours. With that large a work window, we can replace up to four of these spans in that time period.

We do have a fall protection system. That is an A-frame setup which is a very good setup. The top point is well above the worker. He can move up and down the bridge and still be tied off and it won't interfere with his work.

This is another picture of it. You can see the scaffolds that we use. They will cover two spans or three bents with these type of scaffolds. Two scaffolds can cover the opening after the bridge is taken out.

This is a locomotive crane that is attached to the timber and he is removing the deck. There is a set of beams in place with the scaffolding. This guy is welding clip angles down. After we replace the shim plates, we have some clip angles that we replace over the bottom flange of the bridge and weld to the top of the shim plates. That doesn't allow the beams to move sideways. After the beam span is back in place, then the deck panel is replaced with the frame. Then it is fastened to the boom span.

This shows a problem we had on one of our bridges. On this bridge, the bents are skewed to accommodate the channel. What we ended up with is moving the stiffeners for placement over the caps for the top flange to be supported.

On this bridge, we had piling that was rotting down in the drift location so whenever this cap was replaced, the bent was dug out and the bridge gang cut the cap off low enough to get out of the decayed area and then they replaced the cap. What we did was fabricate this little shoe to place underneath the beam sets that matched the top of the cap elevations for the other bents in the bridge.

We presently use three different beam sets for different levels of raising the bridge. We use 18-inch, 24-inch, and 21-inch beam sets. The 24-inch beam sets allow us to remove most large timber shims that we have on our bridges without doing a double capping. The brackets were for our walkway and scaffolding work. This bridge was tall and over water so there was no place for the men to walk and work. So we placed these walkway brackets on the longitude bracing to accommodate the scaffolding for the men.

There is a switch on each end of this bridge and a street crossing so we weren't allowed to do a whole lot of raise on this bridge.

There is a bridge with double caps. You can tell it is pretty long and that one has been in since 1988. We haven't had any problems at all with this bridge and we run coal trains over it.

Here is another shot of the skewed bents. On this bridge, we replaced the deck panel on it with steel stringers and concrete caps. We figured the cost of this bridge was $400 to $500 a foot.

Another thing we are looking ahead at is replacing some of our ballast deck timber bridges. We are looking at using the steel beam sets like this bridge. If the pilings are in good shape, we replace steel beam sets with timber ballast deck panels on top of them. We use the same type of arrangement. We may go to a more evenly spaced beam set.

That's the end of my presentation. Thank you. (Applause)

Mr. Lileikis: Again, thank you, Rick.

Our next feature is entitled "Bridge Construction in Response to Heavy Axle Loading." Don Steele is going to be our presenter.

Don is the immediate past president of the B&B Association. Don has been with the Union Pacific for about 30 years and has held various responsibilities in Union Pacific's bridge department from the gangs all the way through to supervision. He has successfully been what used to be called a general B&B superintendent for the headquarters area, which, if any of you are in the headquarters area, you know that's probably the hot bed of activity because everything is so visible. Please welcome Don Steele. (Applause)

BRIDGE CONSTRUCTION IN RESPONSE TO HEAVY AXLE LOADS UPRR-JOPPA SUBDIVISION

Donald L. Steele

Union Pacific Railroad

In early 1993, the Union Pacific Railroad decided to upgrade its Joppa Subdivision in southern Illinois. The Union Pacific's Coal Marketing Department had successfully negotiated a coal contract requiring heavier unit trains to begin service over the Joppa Subdivision in October of 1994. These heavier coal trains originate in the Powder River Basin, in Wyoming, and travel to an unloading facility on the Ohio River where coal is reloaded onto barges and shipped to power plants upriver.

The primary focus of the Joppa Subdivision upgrade was the replacement of two large railroad bridges; the 845'8" long Little Saline Creek Bridge and the 650'6" long Grasshopper Creek Bridge. this paper presents the story of how these two 1899 vintage trestles were safely constructed in 18 months, under traffic, under budget, and ahead of schedule.

The two 1899 vintage steel frame trestles are located near Goreville, Illinois, which is approximately 20 miles southeast of Carbondale, Illinois. The Little Saline Creek Bridge is an open deck trestle having 23 spans. The superstructure is composed of twelve 47'6" long drop-in deck truss spans and eleven beam spans (one beam span at each of the eleven steel frame towers). The Grasshopper Creek Bridge is of similar construction with 17 spans. The superstructure is composed of ten 47'6" long drop-in deck truss spans and seven 25'0" long beam spans which are identical to the Little Saline Creek Bridge.

The piers for each bridge are concrete pedestals, which are spread footings on soil. The abutments are large, gravity type stone masonry abutments on spread footings. The old abutments were refurbished several years ago, with reinforced concrete to "jacket" around and strengthen the upper portion of the abutment breastwall and backwall.

In March of 1993, the Union Pacific Railroad requested bids from consulting engineering firms for conceptual design and proposed schedules to construct (under traffic) the Little Saline and Grasshopper Creek bridges. Many good ideas were returned. HNTB Corporation in Kansas City, Missouri, was retained to design the bridge replacements. HNTB's responsibilities were to perform the design surveys, prepare the final design plans and specifications, and to develop a span "change-out" procedure that could accommodate a maximum window (no train operations) of 12 hours. Daily work windows were limited to six hours to meet joint line operations with the Union Pacific Railroad and the Burlington Northern Railroad traffic schedules. HNTB completed the work by developing 122 plan drawings and the associated specifications in 93 calendar days. When the final design was completed, the project was advertised for bidding.

Because delivery of the structural steel was a project critical path item, a separate contract for fabrication and delivery of the structural steel was advertised in June of 1993. The remainder of the project which included the construction of the piers, abutments, temporary jump spans, erection of the steel, installation of the ballast pans, raising the bridge to new grade and site clean-up was advertised in July of 1993. The key suppliers for the project were:

1899 Little Saline Creek

1899 Little Saline Creek

General Contractor	Walsh Constr., Chicago
Designer	HNTB Corporation, Kansas City
Structural Steel Fabricators	Stupp Brothers, St. Louis
Specialty Contractors:	
Drill Shaft Install.	Case Foundation, Roselle, IL
Precast Concrete Ballast Deck Pans	Wilson Concrete, Omaha, NE
Steel Erector	Rednoir, Cutler, IL

Bridge Design

The design of the new bridge structures was for a ballasted deck with E 80 live load with diesel impact. The design also included provisions for seismic forces. In 1993, AREA contained no criteria for seismic design and because AREA Committee 9, Seismic Design, was still not organized, HNTB used the AASHTO Seismic Performance Category B for the seismic design criteria. The coefficient of gravitational acceleration was 0.15 G. This was based on the USGS 250 year event specifically stated as a ten percent probability in 50 years.

A single mode analysis was not only performed for transverse loadings, but for longitudinal loading assuming simple spans, and longitudinal loading assuming continuous spans. The longitudinal continuity was assumed to be developed by the ballast and the continuous welded rail on the structure.

Three additional design issues also had to be addressed:

1. Because the existing masonry bridge foundation pedestals were spread footings on soil, the new pier foundations had to be constructed in such a manner as to eliminate any possible disturbance or settlement of the existing masonry pedestals.
2. The existing spans had to be changed-out one or two at a time, because a maximum of 12 hours of track time was all that was allowed.
3. The existing stone abutments were to be replaced due to their age and uncertain performance under the proposed heavier loads.

To solve the issue of foundation stability it was decided not to use traditional pile supported footings where open excavations could be an invitation to settlement or sliding of the adjacent spread footings. Instead it was decided to use drilled shaft foundations which cold be lined with steel casings to retain the stability of the surrounding soil and maintain the integrity of the existing structure during construction.

The issue of span change-out was solved by strategically placing the new piers directly under one of the panel points of the drop-in truss span. This permitted the contractor to completely remove the taller towers during the span change-out sequence. It also provided a convenient way to salvage and re-use a portion of the drop-in truss spans, thus eliminating the need for extensive and expensive temporary jump spans during each change-out.

The change-out was also facilitated by erecting the new spans on cantilever brackets supported by the new pier caps. By utilizing re-usable falsework and jacking frames attached to the top of each pier, a cost savings over ground supported falsework was realized. This span change-out approach also ensure that during each operation, the new spans could be placed immediately after the old spans were removed. All the contractor had to do was slide the new girders into position, using a pair of small winches, which were also mounted to the top of the pier.

The existing masonry abutments were replaced by constructing new abutments behind the old abutments. Temporary jump spans were designed along with a temporary steel end bent and the new concrete abutment was then constructed under traffic, behind the existing abutments.

Description of New Bridges

The new bridge over Little Saline Creek is 878'11" long. The superstructure is composed of ten ballasted deck plate girder spans ranging in length from 51'0" to 121'9". The

3 Pier

4 Span

girder depth varies, from 84 inches to 120 inches. The precast prestressed concrete ballast deck pans are 16'6" out to out and 4'6" long.

The nine substructure piers are composed of twin eight foot diameter column concrete piers which are in turn founded on eight foot diameter drilled shafts which are socketed 20 feet into rock. The columns are typically reinforced with 46 No. 11 bars vertically and horizontally with No. 5 ties varying from 4 inches to 12 inches on centers. The seismic cross ties are No. 5 bars placed at four inch centers, in an interlocking grid pattern.

The substructure capbeams are 8'0" deep and 9'0" wide. The bottom longitudinal reinforcement is composed of 24 No. 11 bars with triple No. 7 stirrups bars for shear transfer.

The new bridge over Grasshopper Creek is 693'5" long and is similar to the Little Saline Creek Bridge.

Construction Schedule

The contract for fabrication delivery for the structural steel was awarded to Stupp Brothers in July of 1993. The General Contractor produced a project schedule calling for steel fabrication and delivery to be on a "right on time basis." From the schedule it can be noted that construction of the concrete substructure began in September of 1993. Actual field work began on September 4, 1993, with the clearing and grubbing and the beginning of the installation of the drilled shafts at the Little Saline Creek.

Drilled Shaft Construction

The sequence of drilled shaft construction was to first use an 8'0" diameter flight auger. Next, a temporary casing 9'0" in diameter was set into the perimeter of the excavated hole to stabilize the top 6 to 10 feet of earth and protect the existing footings from detrimental movements. The temporary casing was incrementally advanced into the ground. First, the 8'0" diameter flight auger was used to removed 18 inches to 24 inches of overburden. The temporary casing was then turned into the hole. This reiterative process continued until the temporary casing was extended below the existing footings.

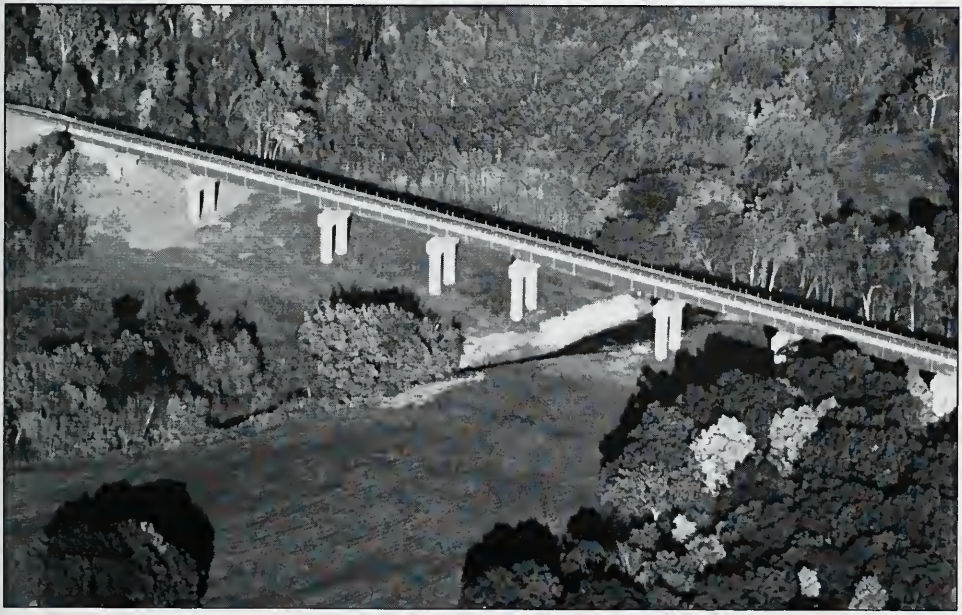
With the temporary casing in place, the smaller 8'0" diameter permanent casing was aligned and then telescoped into the hole and advanced to founding elevation by alternately using the auger to remove the overburden and turning the permanent casing into the ground. The permanent casing was advanced until it seated at top of rock.

When top of rock was reached, the augers were replaced with core barrels ranging in size from two feet to eight feet in diameter. The shaft was cored to founding elevation using the two foot diameter core barrel which also served as pilot hole for future drilling. The large screw auger was used to remove rock, when the rock broke up into smaller fragments and cold not be removed by the core barrels. The process of excavating the drilled shaft continued by using the smaller and then progressively larger core barrels, until the foundations penetrated 20 feet into solid rock.

Once the drilled shaft had advanced to the founding elevation, a 20 foot long by 4 inch diameter rock core was taken at the bottom of the selected shafts to ensure that the drilled shaft would have adequate and bearing on solid rock. With proper end bearing confirmed, the contractor would lift the preassembled reinforcing bar cage into position and carefully lower it into the excavation. Once the reinforcing bar cage was in proper position, the concrete was placed in the drilled shaft using a tremie tube and pumping truck. After the concrete cured, the temporary casing was removed and the small void around the permanent casing was filled with sand.

In most areas the drilled shafts were dry and the surrounding materials could easily be stabilized using eight foot diameter permanent steel casing. In some cases, the shafts would fill with water and neither the temporary casing nor the permanent casing could be advanced quickly enough or deep enough to stabilize the surrounding materials. In these few cases, a benonite slurry was pumped into the excavation to provide an equalizing hydraulic pressure

Change Out – Old verses New.



Saline

and stabilize the surrounding soil material. The benonite slurry was reclaimed as the drilled shaft was pumped full of concrete using a concrete pump and tremie tube. Special precautions were taken at this time to protect the work area and surrounding environment from any damage due to spills and materials overflow.

Reinforcing Bar Cages

While the drilled shaft operation was in progress, the contractor was building the reinforcing bar cages in a "jig," fabricated at the site. The reinforcing bar cages are 7'6" in diameter and were assembled in one piece to extend from the bottom of the drilled shaft to one bar lap length above the top of the permanent casing. The drilled shaft reinforcing cages ranged in length from 30 feet to over 80 feet. The reinforcing bar cages were so large that the iron workers found that it was easier to work from inside the reinforcing cage in lieu of trying to reach between the bars from the outside. This permitted four iron workers to build the bar cages by having two workers on either side of the reinforcing bar mats.

Column Construction

The contractor used specially made, project specific eight foot diameter steel forms for the construction of the columns. The circular steel forms were composed of two half round forms which bolted together in various lengths and easily adjusted to the varying length columns. The column construction progressed by first erecting the preassembled reinforcing bar cage and then sliding the steel column forms down over the reinforcing steel. The forms were secured in position and filled with concrete using the tremie tubes and a pumper truck.

Capbeam Construction

Once the concrete column reached sufficient strength, the column forms were removed and the capbeam construction began. First the side forms for the cap were placed. Because the existing structure prevented the bar cage for the capbeam from being preassembled and lowered into the forms, the contractor used a rebar frame to assist in the placement of the reinforcing steel for the capbeams. The longitudinal bars were placed on the frame and hoisted into position at the end of the capbeam. The iron workers then just pulled the bar across the frame and slid them into the appropriate location in the cap.

Once the reinforcing bar cage was tied together, the ends of the capbeam forms were placed. The anchor bolts for the future spans and temporary spans were secured in position with templates, and after a final check, the capbeam was cast, typically using a concrete pumper truck.

Two key elements considered during the capbeam construction were the location of the bearing device anchor bolts and the projection of the anchor bolts above the top of the cab beam. If the bolts projected too high, the new spans could not be translated across the top of the pier and into their final position. These anchor bolt clearances were rigorously checked to ensure future problems would not occur during the critical 12 hour span change-out period.

Temporary Jump Spans

Construction of the new steel H pile supported abutments was accomplished by first installing a 58-foot temporary jump span behind the existing masonry abutments. Steel piling for the temporary abutment and permanent abutment was driven during the six hour work window the contractor was provided on a daily basis. During the twelve hour track closure, the existing ballast and embankment behind the old masonry abutment were removed; a portion of the old masonry backwall was removed; the steel piling at the temporary abutment was cut off and a steel cap was placed; and a 3/8 inch steel plate was placed behind the temporary steel piles to act as a temporary retaining wall for the approach track embankment fill material. With this preparatory work completed, the prefabricated preassembled temporary steel jump span was placed in position on the old masonry abutment and the temporary pile abutment. The ties and rail were placed on the new span and a safety inspection made prior to opening the track to rail traffic.

New Abutment Construction

Once the temporary jump spans were in place, the new abutment construction proceeded in a conventional manner. First, the footing excavation was completed and then the permanent steel piles were cut off at the correct elevation. The reinforcing steel was placed and concrete forms were set. The concrete was placed using a concrete pumper truck. By later January 1994, the substructure for the Little Saline Creek Bridge neared completion and the contractor moved the substructure construction activities to Grasshopper Creek Bridge and began preparing for the span change-out on the Little Saline Creek Bridge.

Span Change-Out

Preparation for span change-out involved numerous activities. First, the jacking frames and falsework support brackets had to be erected at the top of the new piers. The sliding beams and winches were installed and tested. The more complex work began when the structural steel girders arrived by truck from Stupp Brothers. The contractor simply picked the girders off the truck and set them on the falsework brackets. The lateral bracing, crossframes and inspection walkway were installed and checked for proper fit. The concrete ballast deck pans were placed, along with the safety handrails. The waterproofing was placed and final checks made to ensure all details were addressed.

One the day each span change-out occurred, a carefully orchestrated and sequenced plan of events was followed. Rail traffic was interrupted at 7:00 a.m. The Union Pacific Railroad forces cut and removed the rail at the designated locations. The railroad ties were removed by the contractor. The drop-in truss spans were cut free of the towers using a torch to cut 16 rivets and the spans were lifted out using a crane. The towers were then cut free at the top of the masonry pedestals and simply pulled over sideways by a crane until they fell to the ground.

The falsework skid beams were lubricated using common dishwashing detergent between the stainless steel sliding plates and Teflon surfaces. One winch at each pier was operated simultaneously to slide the new span into position. This sliding of the spans took about two minutes. Track panels were lifted into place directly on the waterproofing and secured to the edge of the concrete pans by using timber struts. After a safety review, the track was opened to service, after as little as 10 hours out of service. Ballast was not placed immediately to minimize the bridge dead weight to facilitate the planned track raise.

Shim packs were used to raise the girders to accommodate for a 21-inch track raise. This was accomplished by taking raised in small steps, so a sharp grade change did not occur. This track raise was accomplished over an eight day period. A deliberate process, but it worked. The shims within the packs ranged from 1/4 inch to three inches thick. Three spans were raised in a given day. One span brought to proper elevation and the next two were brought to differential elevations, so proper track runoff could occur. Track shims were used for final grade adjustment. When the bridge girders were in proper elevation, ballast was dumped and the track was adjusted to final grade and position. The only thing left was the placing of the CWR, final cleanup and touching up of the area.

Points of Interest

Complex projects can be undertaken and successfully completed in a safe environment. There was only one report of an injury and that was a pinched finger. Safety was up front and foremost throughout the project.

Planning must be a joint effort of the designer, contractor and the railroad to ensure the project is visualized and conceptualized by addressing all safety, operational, construction and design related issues and that the project objectives are kept in focus at all times.

Additionally, systematic review of the project plan and schedule is mandatory to verify that the project schedule, cost and quality are continuously addressed.

A check list of events during critical operations helped verify all issues.

The following materials went into the construction of the project.

Description	Little Saline	Grasshopper
Length	878.92 LF	690.75 LF
Bridge No. of Spans	10 Ea.	8 Ea.
Steel H Pile	1093 LF	924 LF
Concrete	1860 CY	1957 CY
Excavation	2200 CY	2200 CY
Reinforcing Steel	883238 LB	755105 LB
Drilled Shafts	934 LF	585 LF
Permanent Casing	355 LF	275 LF
Structural Steel	1360100 LB	943255 LB
Shims	49.88 FT	27.48 FT

The project is a true success story. It was completed under budget, three months ahead of schedule and with only one small injury. What made this happen? I personally believe the answer is simple pride. This was a joint effort of many people who took pride in what was being accomplished. From the very beginning of this project to the conclusion, it was a team effort, from a consultant who was proud of their design and plans, to the contractor who took pride in quality work in a masterful way, to suppliers who responded to most every need, and to the proud employees of the Union Pacific Railroad who felt a sense of looking to the future.

I would like to acknowledge the Union Pacific structural design department, the Union Pacific Railroad construction group, HNTB Corporation, Walsh Construction, Stupp Brothers Bridge and Iron, and Wilson Concrete. These were the major players that made this project a success.

Thank you. (Applause)

New Grasshopper Creek

Mr. Lileikis: That was a pretty dynamic presentation. Thank you.

Next is our standing committee reports. The first report is on education and Jimmy Neece will bring us up to date on the status of our education committee.

STANDING COMMITTEE REPORT

EDUCATION

Jimmy Neece

Supervisor Facilities Maintenance
CSX Transportation

Thank you, Joe. The bridge inspection seminar was very successful last spring and the Association will be conducting another inspection seminar this April 22nd through the 24th. The location of the seminar will be announced later.

Also later this spring, the Association will be conducting its first bridge repair seminar. This seminar will cover some typical repair methods to various types of railroad bridges. Further information concerning these two seminars will be published in the upcoming issues of RT&S and our Association newsletter.

Also on this November 7th and 8th, we will be conducting a railroad construction contracts and project management seminar. One of our past presidents, John Horney, will be the facilitator of this seminar. Further information concerning this is out in the lobby at the registration desk. If you are interested, please sign up. Thank you, Joe.

Mr. Lileikis: Thank you, Jimmy. Next I would like to call John Horney. John is past president of the Association. He is also the chairman of our scholarship committee and I believe he has a few announcements to make.

SCHOLARSHIPS

John Horney

Carter Burgess

Thank you, Joe. First of all, I have to let everybody know that my past task as chairman of the scholarship committee is without a doubt one of the most satisfying and memorable tasks I have ever had the opportunity to work on. I would also be a little remiss if I didn't acknowledge my cohorts on the committee. They were past presidents Don Steele, Jim Budzileni, and Jim Williams.

There is one more acknowledgment I would like to make and that is John Van Huis who is the individual in the Association who actually implemented the scholarship program. He will be on our committee next year as immediate past president.

As chairman of the scholarship committee, I am proud to announce the presentation of our first two scholarships to Sarah Dennis and Todd Wimmer. Both Sarah and Todd received $1,000 scholarships. Sarah Dennis is a daughter of Bill Dennis, Iowa Interstate. Bill, if you are here, please stand up. Thank you and congratulations, Bill. Sarah is a junior at Iowa State University and is majoring in psychology. She has a 3.67 accumulated grade point average and is on the ISU Dean's list.

Todd Wimmer is the son of Bill Wimmer of the Union Pacific. Todd is a senior at the University of Nebraska at Lincoln with an engineering major. He will be graduating very shortly. He has a 3.07 accumulated grade point average. He is a member of the American Society of Civil Engineers, National Society of Professional Engineers, and Todd has already passed his engineering training exam.

Through our seminars and scholarships, the American Railway Bridge and Building Association is very proud to be able to give something back to our members. We truly and definitely wish both of these young people the best of success in their academic and future careers. Thank you. (Applause)

Mr. Lileikis: That is all for the morning. We are adjourned for lunch. Thank you. (Applause)

(Adjourned)

SARAH DENNIS

TODD WIMMER

BRIDGE AND BUILDING
TUESDAY AFTERNOON SESSION
September 26, 1995

Mr. Lileikis: Our first committee report this afternoon is entitled Tunnel Repairs. Although Willie Benton of the Norfolk Southern is the chairman, he has opted to turn the presentation over to the vice-chairman of the committee, Bernie Voor, senior program manager of Ogden Environmental and Energy Services in Nashville, Tennessee.

Bernie is a graduate of the University of Louisville. He has a Master's degree in geotechnical engineering. He has been with Ogden Environmental for about ten years, where he directs the technical activities of the company. He gets involved in geotechnical and environmental consulting.

He has done a lot of railroad work and some work with mining companies in the past. According to Bernie, he is pleasantly married and has three children.

Bernie is a registered professional engineer in five states, Tennessee, Kentucky, Ohio, West Virginia, and Pennsylvania — so he has trouble getting out of the Appalachians. Please welcome Bernie Voor. (Applause)

COMMITTEE REPORT
TUNNEL REPAIRS

Chairman: W. Benton, Engr. Structures, Norfolk Southern

Vice-chairmen: B. Voor, III, Conslt. Geotech Engr., Ogden Environmental & Energy Services
G. Millar, Milbor-Pita Engineering

I appreciate the opportunity to speak here today to the B&B Association. In getting started, I would like to acknowledge my co-authors, Mr. Willie Benton with Norfolk Southern and Mr. Gerry Millar of Milbor-Pita Engineering. I would also like to acknowledge the assistance and help of the other committee members who sent slides and photographs for this particular presentation.

Major Class I railroads own and operate over 600 tunnels on mainline track in the United States. Most of these tunnels were built between about 1850 and 1930. Typically, they are located in mountainous terrain in complex geologic settings and they often form a critical link between major railway corridors. As such, they are vital to the industry's infrastructure system. It is a testimony to the original locating engineers that only rarely can the tunnels be eliminated by line changes or open-cuts, even with today's efficient earth-moving equipment.

Routine maintenance of tunnels is necessary to ensure the long-term integrity of the structure and operational safety through these facilities. Most systems follow a regular inspection and topical maintenance program but have historically not instituted a dedicated program of repair or rehabilitation. Repairs have typically been made on an as-needed basis as a defect progresses in seriousness or on an emergency basis. Often, the maintenance activities themselves can result in the need for repairs or rehabilitation of tunnel systems.

Industry trends and the competitive nature of the marketplace have resulted in recent tunnel rehabilitation programs by some carriers. Specifically, increased clearance requirements for larger freight (i.e. double stack and tri-level auto carriers) have prompted many railroads to modify and upgrade their tunnels. The age and condition of many of these structures made it prudent to conduct more common repairs coincident with the major modifications.

Tunnel repairs and/or major rehabilitation efforts can become costly and disruptive to normal operations. More often than not, such activities must be performed "live track," in windows as short as two hours, greatly affecting repair techniques and construction methods. Cost-effective repairs which can be implemented within tight work windows are vitally important.

The purpose of this paper is to present a wide variety of typical tunnel problems and the types of repairs that have been made to address them. The subject is extremely broad and undoubtedly each repair type can have many variations. Nevertheless, this paper attempts to categorize typical problems and repairs. Specific examples are then cited to demonstrate what others in the industry are doing.

Tunnel Problems

Dramatic variations in geologic conditions and climate across the United States, in addition to the variety of lining systems used in railroad tunnels, give rise to a broad range of tunnel problems. Problems which typically result in repairs can range from relatively minor deterioration of a lining system, to poor surface drainage, to major structural defects. Most tunnel problems can be broadly categorized as: structural; drainage; and/or dimensional. Structural problems include: concrete, brick, and bedrock spalling and deterioration; major liner cracking and distress; timber decomposition; steel corrosion; et cetera. Drainage problems include: seepage, icing; and ballast fouling due to mud pumping. Dimensional problems include vertical and horizontal clearance limitations and obstructions which interfere with track maintenance equipment.

Table 1 gives a general summary of the above categories and typical problems for various tunnel lining systems.

By far the most common structural problem appears to be minor to moderate deterioration and spalling of concrete, brick, and bedrock in respectively lined or unlined tunnels. This is not surprising given the age of most of these structures. Crown seepage and poor ditchline conveyance that subsequently results in icing and accelerated roadbed deterioration constitute serious drainage problems which increase maintenance activities and costs. These common structural and drainage problems can both have serious safety implications. Dimensional problems have been developed relatively recently with the most common being vertical clearance limitations.

Tunnel Repair

Depending upon the specific problem, tunnel repairs can range from traditional type fixes such as reinforced shotcrete applications to address liner and rock spalling, to more specialty type fixes such as tied-back soil/rock anchors or invert struts to address severe liner distress. Unless the problem and solution are obvious, repairs should be appropriately designed with full consideration given to the cause, cost/benefit of repair, constructability, clearance implications, and long-term maintenance implications.

Structural Repairs

Minor spalling and deterioration in lined tunnels as well as minor rock falls and surface weathering in unlined tunnels, is commonly repaired using reinforced shotcrete. This type of repair is also common where old timber sets have deteriorated and where previously applied encasement concrete is spalling. Deteriorated and loose material is usually removed to expose a competent surface. Thereafter, anchor bolts, wire mesh and/or steel reinforcing are installed

and shotcrete is applied. Wet type shotcrete delivery systems seem to be preferred because of their high production rates, low rebound and dust, and ease in handling admixtures. Proper anchorage of reinforcing is important to reduce movement and rebound during shotcrete application. In recent years, many repairs have been made using steel or plastic fiber-reinforced shotcrete to reduce or eliminate the need for pre-installed wire mesh. Fiber-reinforced shotcrete can also reduce subsequent shrinkage cracking. The addition of microsilica improves shotcrete strength and durability.

More serious defects, such as major cracking, bulging, or substantial rock falls, are repaired by a variety of methods. Often a combination of techniques are used. Common repair systems include rock bolts and shotcrete, soil anchors, grouting, underpinning, steel sets, and concrete removal and replacement. The application of these repair systems is usually based on site specific conditions. In situations where defects are localized, existing clearance is tight, and competent soil/rock is reasonably close to the existing tunnel, soil and rock anchorage systems are common. These systems are often combined with a program of grouting behind the liner to strengthen the surrounding soil of rock mass. Where geologic conditions are unsuitable, interior reinforcement in the form of new steel sets or new concrete liners may be applicable. Typically, however, existing clearances do not permit installation of these systems completely within the available cross-section. In that case, the existing liner may have to be partially or completely removed to accommodate the repair.

TABLE 1

Summary of General Categories and Typical Problems for Railway Tunnels

Category	Typical Problems Per Lining System				
	Concrete	Brick	Timber	Steel	Unlined Bedrock
Structural	•Minor spalling •Major spalling •Distress cracking •Bulging •Foundation undermining	•Minor spalling •Major spalling •Distress cracking •Bulging •Foundation undermining	•Decomposition •Liner distress	•Corrosion •Liner distress	•Rock falls •Weathering •Soil intrusion
Drainage	•Crown seepage •Wall seepage •Poor ditch drainage •Icing •Ballast deterioration •Invert degradation	•Crown seepage •Wall seepage •Poor ditch drainage •Icing •Ballast deterioration •Invert degradation	•Crown seepage •Wall seepage •Poor ditch drainage •Icing •Ballast deterioration •Invert degradation	•Crown seepage •Wall seepage •Poor ditch drainage •Icing •Ballast deterioration •Invert degradation	•Crown seepage •Wall seepage •Poor ditch drainage •Icing •Ballast deterioration •Invert degradation
Dimensional	•V&H clearance limitations •Obstructions	•V&H clearance limitations •Obstructions	•V&H clearance limitations •Obstructions	•V&H clearance limitations •Obstructions	•V&H clearance limitations •Obstructions

Undermining of tunnel walls due to previous invert lowering programs or ditching activities can result in wall settlement or convergence. In some instances, material exposed below the original wall footing may begin to slake or pipe into the tunnel resulting in progressive undermining, ditchline obstruction, and/or fouled ballast section. Repairs often consist of underpinning the wall using steel or concrete anchor or pile systems. Invert struts have been used successfully to arrest liner convergence; however, the struts often interrupt drainage and prohibit machine tamping of the ballast. Where poor quality sidewall or invert material is exposed, repairs have included shotcrete, concrete, or asphalt invert paving systems.

Depending upon the location, extent and seriousness of the defect, open-cutting or daylighting a tunnel may be considered. This type of "repair" can be quite advantageous if maintenance is significantly reduced or eliminated and if operational safety is enhanced. Unfortunately, the mere presence of a tunnel usually indicates that site conditions do not favor an open-cut or that such an option is cost or environmentally prohibitive. From a tunnel maintenance standpoint, an open-cut is usually always included in the initial repair option assessment. Open-cut "repairs" have been used in many instances after full consideration of the costs versus benefits, especially when the total elimination of clearance obstruction is considered.

Examples of structural repairs to tunnel are shown in Figures 1-4 and additional project descriptions in Table 2.

Drainage Repairs

Proper drainage control is probably the most important single factor to reducing tunnel maintenance. In this context, drainage problems include surface or side ditch drainage as well as seepage through the crown and sidewalls. Complete geologic conditions and relatively flat grades at most tunnel locations, however, often result in difficult drainage situations. Drainage and seepage problems have become even more serious in colder climates due to ice formation on the track structure or within the tunnel opening. Surface runoff at the portals that is directed through the tunnel often creates the most serious drainage problems because of the large flows during heavy storms.

The common method of improving drainage is simply side ditch excavation and maintenance. In instances where side clearance is limited and spreading of ballast shoulder continues to block drainage, trenches have been excavated below the normal tunnel invert and French drains consisting of perforated pipe and rock fill wrapped in filter fabric have been installed. Where icing is a problem, some carriers have installed electric heat tape within French drain systems near the portals to prevent freezing.

Overhead and sidewall seepage problems have been addressed by a variety of methods. Backgrouting of liners is often used in an attempt to limit seepage or force ground water to discrete collection points. Likewise, chemical grouting of concrete or masonry liners has been used to seal these materials and redirect ground water flow. Grouting programs in lined tunnels are often accompanied by the installation of weep holes and vertical drains to collect and convey seepage to the ditch lines. Depending upon clearance requirements or the need to insulate the weeps and drains, recessing into the liner may be necessary. If conditions warrant, these seepage collection systems can also be equipped with heat tape to prevent freezing. When icing is a major operational problem, insulated shields have been used to raise the temperature of the lining above freezing and to collect the seepage in pipes which are heat taped. This almost always requires major clearance improvement to make space for the shields.

Another type of seepage control system includes overhead drip shields which typically divert seepage away from the track structure. Drip shields typically consist of steel or aluminum arches attached to the roof using anchors or rock bolts. Polyethylene shields are becoming more common because of their light weight and protection from corrosion. Unless insulated or heated, drip shields do little to prevent icing. They can, however, help control the

TABLE 2

Examples of Structural Repairs to Railway Tunnels

Name/Location	Owner	Tunnel Type	Problem	Repair Description
Solway Tunnel Solway, TN	CSX Transportation	Reinforced Concrete Lined	Major shear crack at springline. Inward rotation of wall and settlement of crown.	Underpin wall footings with steel pipe piles. Install struts at invert to stop wall convergence. Install soil and rock tieback anchors to stabilize walls and install deadmen anchors from surface to support crown.
Pioneer Tunnel Scott County, TN	Norfolk Southern Corporation	Unlined (Exposed Bedrock)	Solution weathering of host limestone bedrock causing moderate rock falls with soil intrusion.	Seal soil seams in roof and walls with bulkheads and backgrouting. Install post-tensioned rock bolts in high risk areas and patterned rock bolts throughout.
Marengo Tunnel Marengo, IN	Norfolk Southern Corporation	Brick-lined with intermittent shotcrete	Deterioration and spalling of weak brick and spalling of previous shotcrete repair areas.	Tunnel ultimately modified for double-stack clearance. Brick crown back-grouted and fiberglass bolted followed by crown mining and replacement with steel channel liner. Deteriorated wall areas backgrouted followed by 8-inch deep brick removal, rock bolting and fiber-reinforced shotcrete. Remaining brick walls backgrouted and stabilized with rock bolts.
Indian Grave Tunnel (Bypass Project) Jacksboro, TN	Norfolk Southern Corporation	Concrete-lined	Major spalling, cracking and failure of tunnel liner as alignment crossed active geologic fault.	Construct open-cut bypass parallel to existing tunnel. Complex geology resulted in significant slope stabilization and resulted in an open-top, strutted, reinforced concrete tunnel about 600 feet long and 30 feet high. Approach cut stabilized with wire basket gabion retaining wall system.
Mansion Tunnel Altavista, VA	Norfolk Southern Corporation	Concrete-lined	Spalling of concrete liner and equipment clearance limitation due to concrete footing. Also seepage through liner.	Designed repair for spalled areas to consist of saw cutting and mechanized concrete removal followed by installation of short anchors, reinforcing steel and replacement of 3000 psi concrete.
Blueslide Tunnel Blueslide, WA	Pend Oreille Valley Railroad	Timber-lined	Deteriorated timber sets and completely failed sets in glacial soils.	Encased failed timber sets in new lining of steel sets and concrete. Steel sets continuously lagged with steel channel to create a form that was backfilled with concrete. This avoided removal of the timber sets and likely collapse of the tunnel.
Mullan Tunnel Blosberg, MT	Burlington Northern/ Montana Rail Link	Concrete	Sidewall failure due to shearing in faults zone.	Grouted and anchored sidewall that pushed in up to 18 inches of fault zone. Later, used roadheader to mill the concrete leaving only a 6-inch protrusion from original design.

(A)

(B)

FIGURE 1:

Structural Repair of Deteriorated Brick Lining at Marengo Tunnel; Norfolk Southern Corporation. *Repair included:* (A) removal of outer brick courses and installation of anchors, reinforcing steel and back drains; (B) reconstruction of wall face using plastic fiber-reinforced shotcrete.

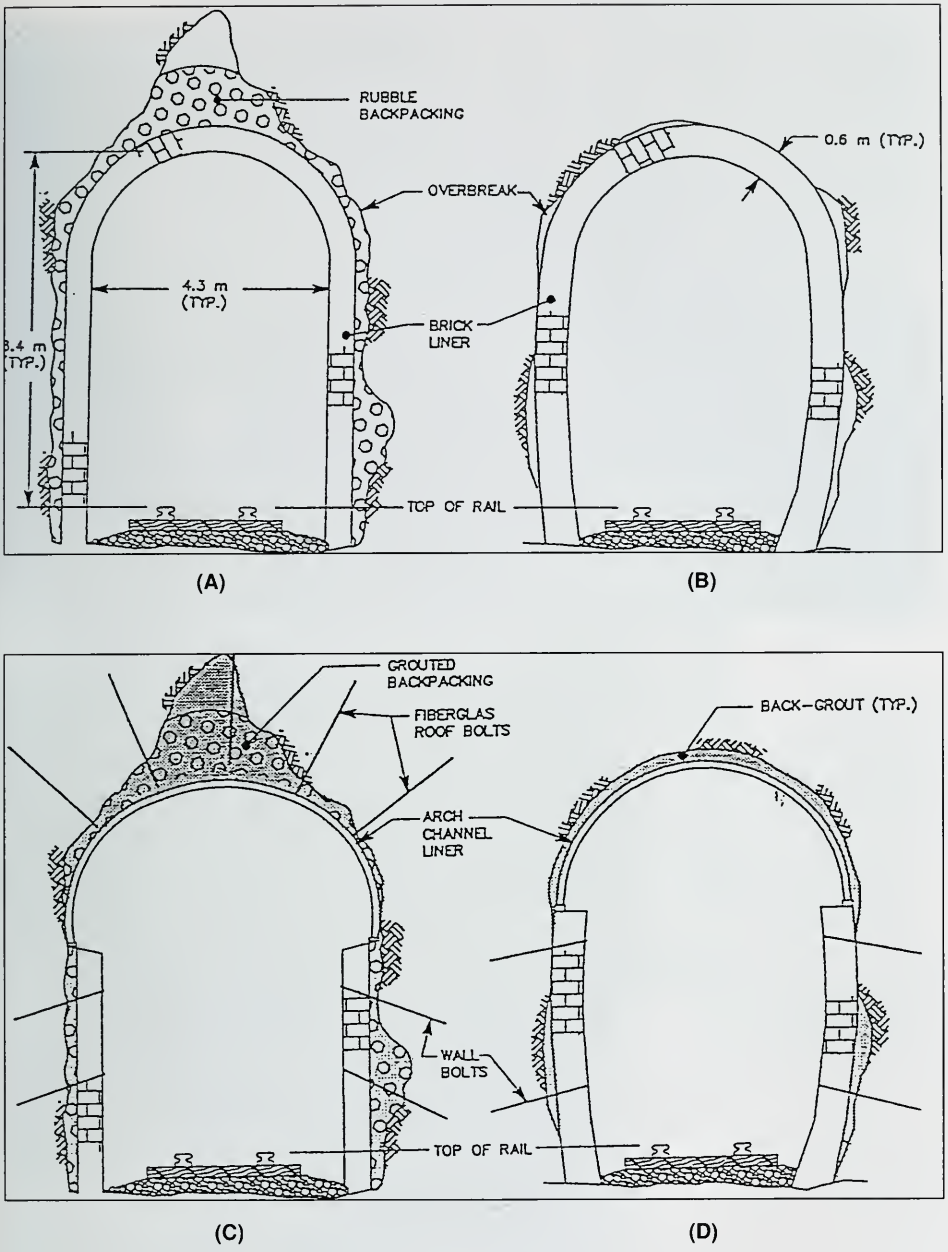


FIGURE 2:

Structural and Clearance Improvement Repairs. Marengo and English Tunnels. Norfolk Southern Corporation. Generalized cross-sections of tunnels prior to repair: (A) Marengo; (B) English. Typical cross-sections of modified tunnels; (C) Marengo; (D) English. Rubble backpacking behind Marengo liner was grouted and pinned with fiberglas roof bolts. Brick liner was removed by roadheader and new steel channel liner installed above springline. English liner removed by hand-mining in short segments often leaving outer brick course for temporary roof support. New steel channel liner installed above springline and backgrouted.

(A)

(B)

FIGURE 3:

Clearance Improvement to Marengo Tunnel; Norfolk Southern Corporation.

(A) Brick liner backgrouted and anchored with fiberglas bolts followed by roadheader.

(B) Completed repair with new crown of steel channel liner atop brick walls.

(A)

(B)

(C)

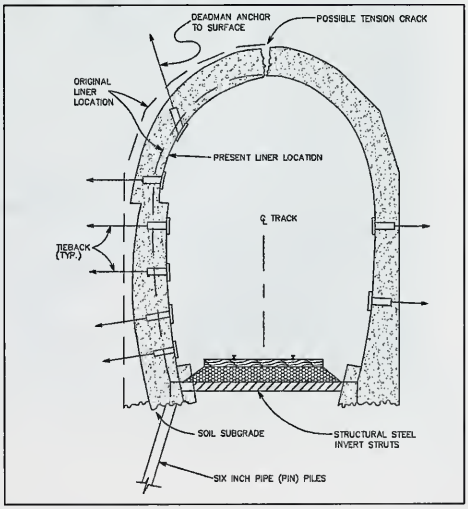


FIGURE 4:

Structural Repair to Solway Tunnel; CSX Transportation:

(A) Tunnel interior showing shear crack and displacement of right wall at springline; soil and rock anchors used to tie-back wall; small diameter steel pipe piles used to underpin walls;

(B) deadman anchors installed from surface to support crown;

(C) typical cross-section of repair system.

location of icing relative to the track. In some instances, drip shields also provide some protection against minor rock falls or spalling by deflecting such materials away from the rail. On the downside, drip shields typically mask the liner or bedrock roof preventing or making inspection and detection of defects difficult.

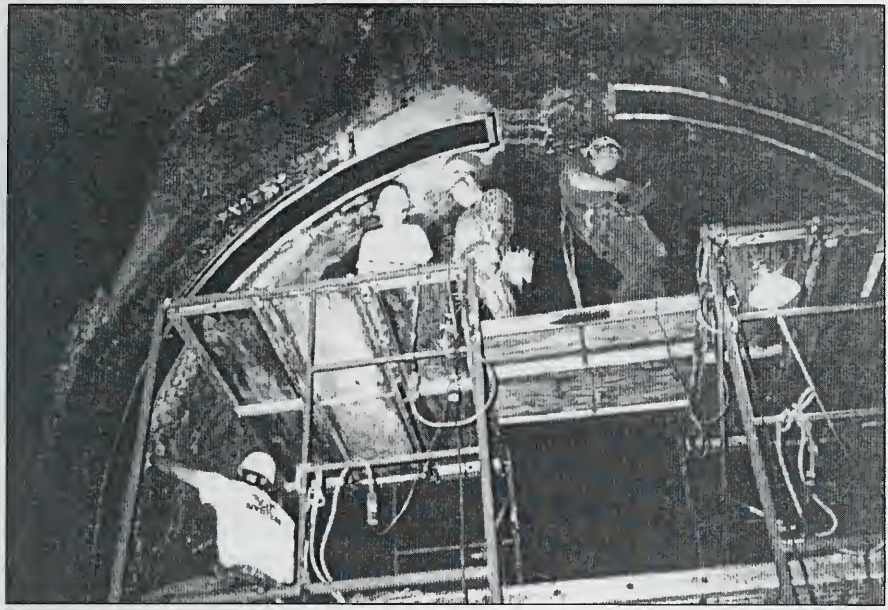
Figure 5 shows some recent repairs made to address seepage. Examples of tunnel repairs which address drainage and seepage problems are provided in Table 3.

Dimensional Repairs

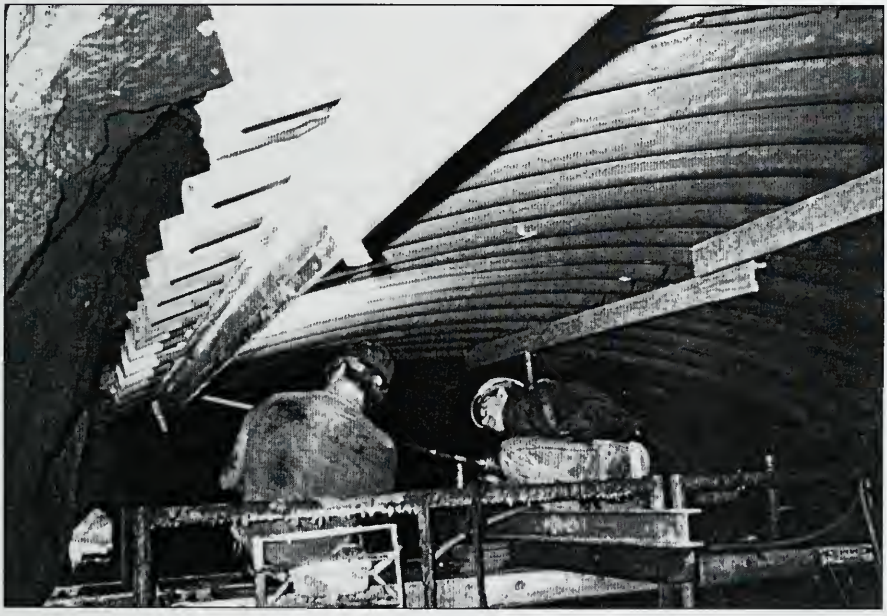
Dimensional repairs are another form of structural repair but are considered primarily as clearance improvements. They may or may not include repair of other tunnel defects. Clearance improvements are typically obtained by: invert lowering; crown mining or notching; total crown or liner removal and replacement; or, open-cutting. Track lowering would seem to be straightforward: remove the track and ballast, excavate the soil or rock, and replace the track. However, this type of repair is usually very disruptive to rail traffic and can involve significant approach grade modifications. In some instances, invert lowering has caused wall undermining wherein anchorage systems and backgrouting have been required to maintain liner stability. Never undercut the footings in the tunnel, retaining wall, or bridge pier. To do so can result in disastrous structure failure.

Crown mining or notching typically involves the use of a roadheader or saw to grind or cut a portion of the liner in the arch areas. In unlined tunnels, bedrock "tights" are often removed by controlled blasting. Thick concrete and masonry liners may be capable of supporting loads after crown mining without additional reinforcement. Where lining thickness is marginal or insufficient, crown mining is usually accompanied by a liner backgrouting and rock bolting program. Often, shotcrete or thin profile steel straps are used to re-establish arch support in deep notch cases.

(A)



(B)



(C)

FIGURE 5:

Seepage Repair of Goodview Tunnel; Norfolk Southern Corporation: (A) Chemical grouting and patching of concrete crown; (B) Installation of filtered-weep holes and thin profile vertical collection drains (high density polyethylene with aluminum battens); (C) Installation of overhead plate arch drip-shield or canopy.

TABLE 3

Examples of Railway Tunnel Repairs to Address Seepage / Drainage Problems

Name/Location	Owner	Tunnel Type	Problem	Repair Description
Goodview Tunnel Bedford County, VA	Norfolk Southern Corporation	Partial concrete-lined; mid-section unlined (exposed bedrock).	Seepage through liner and bedrock with icing and ballast fouling. Also minor rock spalling in unlined reach.	Conduct chemical grouting of concrete crown and install system of filter-fabric covered weep drains through liner which discharges in thin-profile, polyethylene collection drains on liner surface. In parts of unlined reach, install a roof dowel suspended aluminum plate arch drip shield to deflect and divert rock falls and seepage away from track.
Mansion tunnel Altavista, VA	Norfolk Southern Corporation	Concrete-lined	Seepage through portions of liner causing deterioration of liner and track structure in addition to winter icing. Also spalling of concrete liner equipment clearance limitation caused by concrete footing projection into ditchlines.	Designed seepage remediation system consisting of chemical grouting of crown along with installation of filtered weep drains through liner. Weep drains discharge into thin-profile, high density polyethylene drain attached to tunnel walls to direct flows to ditchlines.
Mill Creek Tunnel #2 Carrollton, KY	CSX Transportation	Brick-lined	During previous clearance improvement program, undercut invert to gain vertical height. Undercut exposed very weak, high swell clay shale in invert resulting in fouled ballast and poor drainage.	Designed invert repair system to consist of asphalt seal over weak bedrock, gravel drainage layer and 8-inch to 12-inch thick asphalt pavement.
M.P. 51 Tunnels (5) Portage, AK	Alaska Railroad	Unlined	Severe icing on walls and track.	Insulated shields consisting of steel/ polyurethane sandwich placed full-perimeter. Insulated drains drop seepage collected by the shields out from the portal.
Allegheny and Spruce Creek Tunnels Altoona, PA	Conrail	Shotcrete/ concrete lined	Severe icing on walls and track.	Insulated shields consisting of steel/ polyurethane panels placed full-perimeter. Insulated drains drop seepage collected by the shields out from the portal.
Moffat Tunnel Winter Park, CO	Southern Pacific Lines	Concrete-lined	Track heave at west portal for several hundred feet.	Place pavement of wood/polyethylene panels (4" thick) over the ballast from wall to wall with heat tape in particularly troublesome spots. Panels are removable for routine track maintenance work.
Moffat Tunnel Tunnel 16 Dean Tunnel, CO	Southern Pacific Lines	Concrete-lined	Wall ice.	Place polyethylene panel pinned to the sidewalls and crow to eliminate ice and control seepage.

TABLE 4

Examples of Railway Tunnel Clearance Improvements and Repairs

Name/Location	Owner	Tunnel Type	Problem	Repair Description
Mansion Tunnel Altavista, VA	Norfolk Southern Corporation	Concrete-lined	Equipment clearance limitation due to concrete footing projecting into ditchlines. Also seepage through liner and general liner spalling.	Designed repair to consist of saw cutting to remove concrete footing projection to improve side clearance for maintenance equipment and to improve ditchline drainage. Analysis showed no grouting or anchoring required.
English Tunnel English, IN	Norfolk Southern Corporation	Brick-lined	Vertical clearance restriction for double-stack freight.	Backgrouted and rockbolted walls. Removed arch and crown brick above springline by roadheader and replaced with new galvanized steel channel liner arch atop brick walls.
Marengo Tunnel Marengo, IN	Norfolk Southern Corporation	Brick-lined	Vertical clearance restriction for double-stack freight.	Backgrouted brick-liner and backpacking. Stabilized walls with rockbolts. Pinned roof mass with fiberglass bolts followed by roadheading of brick above springline. Replaced arch and crown with new galvanized steel channel liner atop brick walls.
Montgomery Tunnel Montgomery, VA	Norfolk Southern Corporation	Concrete-lined (twin tunnels)	Vertical clearance restriction for double-stack freight.	Conducted crown mining to remove concrete liner and rubble backpacking. Rock bolts and shotcrete used to re-establish interior roof. Lattice girders and shotcrete used near portals for new roof.
Shawsville Tunnel Shawsville, VA	Norfolk Southern Corporation	Brick and masonry-lined	Vertical clearance restriction for double-stack freight.	Open-cut tunnel.
New Portage Tunnel Gallitzin, PA	Conrail	Brick and masonry-lined	Vertical clearance restriction for double-stack freight.	Lower track 3.5 feet. Stabilized existing lining by underpinning sidewalls with deep footing wall, and covering liner with 4 inches of fiber reinforced microsilica shotcrete.
Tunnels 41, 42, 43 Elko, NV	Union Pacific Railroad	Timber-lined	Vertical clearance restriction for double-stack freight.	Removed timber sets and re-lined with shotcrete and rock bolts in daily 6 hour work windows.
Tehachapi Tunnels 12 Tehachapi, CA	Southern Pacific Lines	Various linings	Vertical clearance restriction for double-stacks.	Combination of track lowering up to 12 inches, and liner notching up to 8 inches after grouting and placement of sidwall rock anchors. Combined program eliminated costly total liner removal in this 70 MGT line; all work performed in daily 6 hour window.
Western Canada Tunnels (26) British Columbia and Alberta	Canadian National Railway	Various linings	Vertical clearance restriction for double-stacks.	Combination of track lowering up to 12 inches, and liner notching up to 8 inches after grouting and placement of sidewall rock anchors. Combined program eliminated costly total liner removal in this 50 MGT line; all work performed in daily 6 hour window.

(A)

(B)

FIGURE 6:

Clearance Improvement by Open-Cut of Shawville Tunnel; Norfolk Southern Corporation: (A) Original tunnel portal; (B) Open-cut activities progressing.

Repair or enlargement of tunnel lining systems by total removal and replacement methods is typically difficult. When used, the technique involves a temporary ground support system of grout, soil/rock anchors, or shotcrete before or after liner removal. Thereafter, the replacement liner is installed and typically backgrouted. This type of repair usually has a high unit cost but often results in lower long-term maintenance costs relative to other liner modification systems.

Open-cut "repairs" are self explanatory. They generally result in unlimited clearance improvements. As noted previously, however, this method is often cost-prohibitive and if used, could simply shift maintenance efforts from those of the tunnel variety to those of the slope stability and drainage variety. A decision to open-cut a tunnel must include an assessment of long-term slope maintenance costs. On heavy traffic systems, open-cut type "repairs" can become quite cost-effective if they can be performed with little disruption to train traffic. This may require an alignment shift or bypass technique.

Figure 6 shows a tunnel open-cut project for clearance improvements. Examples of tunnel clearance improvement and repair projects are given in Table 4.

Tunnel Repair Success

Overall, most tunnel repairs are considered successful, particularly those used to address major structural distress or clearance improvements. The term "marginally successful" often applies to minor repairs made to address surficial spalling and liner deterioration or drainage improvements. In these cases, the mere nature of the problem often prevents the repair from being "fully successful" because rarely is a "walk-away" type fix employed. Instead, an observational repair approach is often used at lower initial construction cost but with ongoing maintenance effort. In addition, otherwise successful repairs can sometimes be labeled "marginal" when they directly or indirectly contribute to another problem. An example would be an invert undercutting and lowering repair which subsequently causes undermining of a liner wall.

Although drainage and seepage control repairs are often short-term improvements requiring maintenance in subsequent years, some carriers report very successful results, particularly in the control of icing. Insulated shields and seepage collection systems consisting of filtered weep holes and thin profile vertical surface drains, both with and without electrical tape, have substantially reduced manual ice removal activities. Similarly, heated side drains and insulated invert panels have reduced invert icing and heave.

Summary and Conclusions

The railroad industry's tunnels have served well over the past 100 to 150 years. These structures are important links in a vast infrastructure network. Repairs to tunnel are necessary to ensure safety, reduce maintenance and remain competitive in the transportation marketplace. Tunnel problems are quite variable and the associated repairs must be cost-effective. The repairs must also be suitable for implementation under a unique set of construction conditions. Often, the need to perform a repair under live track conditions will cause otherwise traditional repairs to become infeasible.

The railroad industry has become quite creative in developing repair systems which satisfy constructability and economic requirements. Personnel faced with tunnel repair challenges are encouraged to share their experiences so that the entire industry can benefit.

I appreciate your time. If there are any questions or for that matter if there are any other tunnel repairs that have been attempted and not covered here, I would be happy for you to stand up and share those with the group.

I am certainly an advocate for sharing technology.

Thank you. (Applause)

Mr. Lileikis: Thank you, Bernie. Our next feature is called Philadelphia Data Center and will be presented by George Andreas, staff engineer construction, Conrail. George graduated from Lafayette College in 1976 with a Bachelor of Science degree in civil engineering. He received his professional engineer's registration in the State of Pennsylvania in 1980.

Since joining Conrail in 1976, he has held a number of positions in the engineering department. Following a three-year assignment on track supervision with the maintenance-of-way track department, he joined the engineering department management group in Philadelphia where he has worked in construction on numerous capital construction projects.

From 1979 to 1984, George handled the contracting and scheduling for the $40 million modernization of Conrail's Pier 124 coal handling facility in Philadelphia including construction of a new 1,400 ton traveling shiploader and related coal handling system.

As staff engineer construction at Conrail's design and construction department since 1984, he has handled the contracting for a variety of major capital projects including tunnel clearance improvement at Conrail's four River Line tunnels in New York State.

Most recently, George has handled all the contracting relating to the construction of Conrail's new technology center in Philadelphia. This $40 million project involves 45 separate design and construction contracts for the construction of a new 25-acre, five-building computer data center and office complex. He will bring us up to date on that project. Please welcome George. (Applause)

PHILADELPHIA DATA CENTER

George Andreas

Staff Engineer Construction
Conrail

Good afternoon. My name is George Andreas and I am with Conrail's engineering department. I have been involved in a variety of capital construction projects in the past, but none as intense as the construction of the Conrail Technology Center. I'd like to thank the Association for the opportunity to tell you about some of the unique features of this facility and the design and construction issues we had to face.

Because the technology center is our only data handling facility, the importance to our company is pretty obvious. It supports all of our business applications such as customer records, billings, employee records, payroll, et cetera, and enables communications with all Conrail facilities and customers. It supports all of our Information Systems applications. But don't confuse it with a centralized train dispatching facility. While it maintains the records of every shipment made on Conrail, it is not used for the day-to-day operation of trains.

The facility is located on a 25-acre wooded site in Northeast Philadelphia. It is about a half-hour drive from our corporate offices at Two Commerce Square in downtown Philadelphia.

The project involved construction of five adjoining structures totaling 122,000 square feet. These structures include:

– Two two-story computer bays known as Alpha and Beta.
– A two-story mechanical electrical bay.
– A two-story office building.
– A single story command center.

The two-story office building provides space for 200 systems personnel. It also includes extensive printing facilities, a cafeteria, and a loading dock.

The Alpha and Beta computer bays stand side by side with the mechanical electrical building to the rear of them. These two computer bays are mirror images of one another. Think of it as a 100 percent backup since only one of the bays is required for operation at a time. One bay houses a mainframe IBM computer while the other houses an Amdahl mainframe. The was done so we wouldn't be dependent upon a single computer manufacturer. This was done with many of the computer systems at the center. The mechanical/electrical bay area contains all of the HV switchgear and cooling equipment needed to provide a continuous flow of chilled water. This chilled water flow is important since it isn't just for the air-conditioning system, but it's also needed to supply cool water to the computers themselves.

A single-story command center is centrally situated between the office building and the computer bays. It is the nerve center of the facility since it regulates the telecommunications network in addition to the computer and security systems.

You might ask why Conrail needed a computer facility of this magnitude. Before 1991, Conrail operated two separate but interdependent computer data centers in the Philadelphia area. These had been operating since 1960 and 1984. These two facilities were outdated and were in need of upgrades in order to meet Conrail's expanding computer needs. Interdependency meant that a major disruption at either facility would have shut down operations at both. This was a major concern since the existing data centers were not hardened, meaning they were likely to be disrupted at some point by either man-made or natural events. They were also becoming unreliable due to lack of back-up systems and a dependence on local utility companies for power.

Our mission was to design and construct a new state-of-the-art facility to consolidate and upgrade Conrail's two existing data centers. It would seek improved system reliability by including redundant back-up systems, hardened components, and upgraded security. It would also provide for growth in applications well into the next century.

The goal for migrating our computer systems to the new facility was set at July 1993. This only gave us 17 months to complete the work. With about five months for design, that left 12 months for the construction. This compressed schedule saved us millions of dollars in lease renewals and temporary upgrades at the old facilities.

We used a "team concept" involving Conrail's information systems and engineering departments to drive the project to completion. Teams of engineers and systems experts worked side by side to define Conrail's requirements for the new facility and to select the principle design and construction professionals who would be needed. We selected The Kling Lindquist Partnership, an architectural firm from Philadelphia, to perform the final design. We contracted separately for experts in specialty areas such as hardening features, vibration and soil analysis, audio-visual systems, telecommunications, and cafeteria design. A process improvement team (or PIT team as well call them at Conrail) made up primarily of information systems employees also had a say in the design development.

Some of you may have heard stories about "bunker-like" conditions at this facility. I've even heard it referred to as Saddam Hussein's bunker. The fact is that because of the criticality of this single facility to Conrail and the need for reliability, the project is hardened. In other words, the buildings and site features are designed to withstand severe man-made and natural disasters without affecting computer operations. Some of the events considered were: Tornadoes and hurricanes where you could have wind-driven objects like telephone poles

flying on end up to 160 mph; or three-ton projectiles falling from the sky like an aircraft engine or light plane. Hopefully none of you will be testing this feature on your way home from this conference.

The design also considers various kinds of potential explosions. We even considered the remote possibility of a derailment on our adjacent track which could conceivably involve explosives. It can withstand short or long term power outages and is resistant to the types of earthquakes in this area.

Now to discuss some of the hardening features incorporated into the sitework. For example, I mentioned the remote possibility of derailment on our adjacent track. To insulate us from any conceivable event on the tracks on Conrail's Trenton Line (running from Philadelphia to Trenton, New Jersey), we constructed a 15-foot high earthen berm between the tracks and the ring road. We were also concerned about vibrations from passing trains since computers are highly sensitive to such vibrations. We had specialists measure and record these vibrations and reviewed them with IBM and others to ensure this would not be a problem. It wasn't a requirement to locate the facility next to our tracks. It just so happened that the optimum site was located here.

We have earthen berms surrounding the computer and mechanical bays. In fact, the portion of the computer bays that you see here are actually only the second floor. The mainframe computers on the first floor are, in essence, below ground. In the outside equipment yard, at the rear of the building, there are cooling towers.

There is a 110' microwave tower. The facility primarily communicates by microwave transmission with other locations such as our corporate offices downtown. It has fiber optic cable, which comes in adjacent to our tracks, as well as conventional telephone lines. This, again, is considered a redundancy to enhance the reliability of the facility.

We've also incorporated a state-of-the-art security system so that man-made actions will not affect system reliability. All gates and doors have card access with authorization codes. Fences have motion sensors. Entrance to the highly secured areas require passage through a mantrap involving palm imprint recognition, metal detection, explosive sniffers, and weight measurement. Add to that, bullet-proof guard stations and continuous TV surveillance, and we believe we've created a reasonably secure environment.

At the main gate at the entrance guard booth, you'll find what looks like a light pole, but it is actually a remote TV camera. Visitors to the facility are directed to a parking area where they can be cleared for admittance to the office building. Employees, on the other hand, may enter directly through the two gates to the parking area with appropriate cards and codes. They will also need their cards to pass through the turnstile area and the front door of the office building.

Access to the highly secured areas requires passage through a device known as a mantrap. You enter in and the door closes. You place your palm in a device with your appropriate codes. Your palm imprint is read, and you're scanned for metal, sniffed for explosives, and weighed to make sure you're alone. If the computer is satisfied with these results, the door opens and you enter into the secured area. If not, then neither door will open and you remain trapped until security determines what to do with you.

In the main lobby behind bullet-proof windows, the guard can monitor any one of 22 cameras on the four monitors. Many of these cameras are remote controlled using the joystick on the desk. From here, the guard also monitors the mantrap entrance, the office building entrance and all fire and security systems.

On the south side of the facility, there are additional security features. For example, there are no windows or rooftop entrance points on the secured bays. The fence is lined by trees and a second fence is inside the ring road. During meetings with our security experts, I've heard them refer to the area between the fences as the KZ (a term veterans may know as a kill zone). I think the guy who came up with that was working a little bit too hard. There's no weaponry installed — it is not part of our construction budget.

As I said, there is a berm protecting the computer bays. The office building doesn't have a berm, and, in fact, has windows as any normal office building. Remember we're protecting the mainframe computers and Conrail's data; not providing a bunker for our information systems employees. The precast concrete wall panels give the building a very attractive appearance.

As part of the need for reliability, the facility has an uninterruptible power supply or UPS system providing continuous, regulated power to the computers. This is basically a battery bank consisting of 500 batteries, which can run the computers for about 15 minutes in the event of a total power loss. After that, either the second power feed would have to come on line or the emergency generators would have to kick in.

The UPS system also regulates the flow of current to the computers to avoid surges. We use switchgear to regulate that current and, again, there is an identical room for each computer bay. This UPS system could supply the electrical needs of 400 single family homes.

We receive power from two substations fed from two separate generating plants in case one would shut down.

We have four emergency backup generators installed in the mechanical electrical bay. Two generators support each computer bay. A single Detroit diesel generator can produce 1600 KW at 13 KV which could light about eight miles of fluorescent tubes, or supply 130 homes with power including air conditioning. In the event of a total power loss, the facility could be run from these generators indefinitely. They're supported by three 15,000 gallon fuel tanks.

In the computer bays, the roof support beams are 24" precast double T-sections. An additional concrete slab similar to a bridge deck was placed on top of these bringing the roof thickness to over 12" of reinforced concrete in the hardened areas. There are two miles of sprinkler system piping and air handling ductwork. On the floor are chilled water piping loops. The square grid on the floor slab is a copper mat for grounding the raised floor pedestals which are two feet in height and will support a raised computer floor. Beneath this raised flooring are miles of conduit and cable connecting the computer equipment. The two-foot space below is pressurized with cooled air to keep things from heating up. But with all this cabling there is potential for fire beneath the floors. We, therefore, have different types of fire protection available to deal with such a situation in addition to the conventional sprinkler system. Adjacent to the typical CO2 extinguisher hanging on the wall, we have two large halon tanks. Halon gas is a vapor that works chemically to stop the combustion process itself. It's used in computer areas since it is clean and leaves no residue behind while extinguishing most fires within seconds after release. It also leaves plenty of oxygen in the room for people to breathe while they leave the fire area.

In the computer bay area, the halon would discharge beneath the floor, but in the data storage areas, it would discharge both above and below the floor which is called "full flood" halon protection. There is also a CO2 system that has a larger capacity than a typical CO2 extinguisher.

In the event of a fire beneath the flooring, the fire detection panel would light up showing the location. Equipped with an extinguisher, or a CO2 hose, a person could go directly to the location, remove the floor panel and investigate or extinguish the fire. If serious enough, a halon dump would then be initiated. A smaller panel also provides a leak detection display in the event any of the piping should spring a leak.

In the main lobby entrance in front of the command center, there are bullet proof windows which allow you to view into the secured command center. You can also see the main guard station and the entrance to the office building. Behind the guard booth is a mantrap leading to the secured areas. There is a semicircular flooring and ceiling which the command center follows. Because it follows this concentric, semicircular design, there were a host of problems encountered during the construction. For example, circular caisson locations,

foundations, walls, floors, ceilings, piping, and metal paneling, to mention a few. We, in engineering, resisted this curved configuration but it soon became apparent that our systems people and our architect had their hearts set on this semicircular design and were not going to budge.

So far, I've talked a lot about the design features that were built into the facility. Now, I would like to focus a little more on some of the construction aspects with which we had to deal.

In order to meet Information System's goal of having a complete operating facility in 17 months, by July 1993, we recognized the need for a true fast track approach. The office building was substantially completed in 10 months, from April to January. The computer and command center areas were completed in 12 months, from April to March. Telecommunications work was completed between January through June supporting final systems migration in July 1993 as planned.

Those of you who have worked on fast track projects before may have heard it compared to putting on your shoes and your suspenders before you put on your pants. In other words, you're constructing foundations before the design is complete for the building. You're constructing the building before the design is complete for the interior piping and electrical systems, and so on. As soon as the design for the next phase of work is complete, bids are taken and contracts awarded, and you start to work as soon as the person ahead of you gets out of your way.

Once the design was well underway, we expanded our team to include the Gilbane Building Company of Princeton, New Jersey, for their construction management expertise. Gilbane had demonstrated their fast track experience with previous facilities of this kind and turned out to be a good fit with our team. You can just imagine the coordination required between 35 construction contracts, 10 design consultant contracts, all working on a congested 25-acre site together with 300 workers during the peak construction period. The full-time presence of Conrail's Bill Schoen, assistant chief engineer construction, now retired, and Mike Hoey, engineer construction, were needed in addition to our architect and the Gilbane project staff to direct this effort. Of course, we also received the support of Jerry Cossel, chief engineer construction, and Gerhard Thelen, AVP engineering and design, when needed.

We used a computerized CPM scheduling package known as Primavera to help us plan and track the complex design and construction effort. Our master schedule network involved 1,000 activities not including separate schedules maintained by the subs for their work. This scheduling took a lot of effort but was absolutely essential to ensure that nothing fell through the cracks in the midst of all the design and construction changes.

Because of the presence of compressible clay-silt soil layer underlying the facility, caissons were selected for foundation support. Caissons were 3 to 4.5 feet in diameter and averaged 30 feet in depth to rock. Following the drilling of the hole a steel sleeve was inserted and a worker was lowered into the hole to clean out the bottom. An inspector was then lowered into the hole to probe the bottom to make sure we had reached solid rock. I understand caisson contractors are always looking for a few good men for this kind of work if anyone is interested.

The caissons were poured in May of 1992 just days after the site had been cleared of trees and was excavated to grade. Reinforcing was placed and the sleeve was retracted as the caisson was poured. There were 150 caissons installed in this manner. As soon as there were sufficient caissons to work with, the foundation contractor began forming the cast-in-place grade beams supporting the walls.

In June, the cast-in-place foundation walls and precast columns and slabs were installed at the rear of the computer bays. Also during June and July, work progressed on the installation of the precast wall sections. These panels were 23 feet high, 12 feet wide, and 12 inches thick for the computer center and 6 inches thick for the office building. They arrived on

trucks from central Pennsylvania and were unloaded and set on delivery to avoid any storage space on site for them.

By the end of July 1992, the mechanical electrical bay began to take shape at the rear of the computer bays. Most of the precast wall sections had been set and the first precast columns were set for the office building which will be completed in another five months.

By the end of August 1992, the precast wall panels had been set entirely for the office building as well as the computer building. Interior fitout could now begin in September. At the rear of the facility are square openings which are for the emergency generators; the round openings are for exhaust manifolds.

Interior fitout work was proceeding in the last quarter of 1992. Chiller units were installed which cool the water beyond what can be obtained by the cooling towers. In the winter when a lesser degree of cooling is required, heat exchangers will be used to cool the water in conjunction with the cooling towers.

The maintenance bay is referred to as the "rainbow room." There are two chillers and pipes in the background. We use color coding to identify which loop the pipes are on, whether it's chilled water going to the bays, or returning from the bays, or going to the cooling tower, or returning, and so on. This coding scheme has been a real help to the maintenance forces. The pipes have automatic flow control valves and a sophisticated, computerized flow control system.

About the same time as the chiller installation in early January, 1993, the office building was substantially completed while the mechanical areas were still about two months from completion. The windows which encircle the office building really give the building an open feeling, particularly with the wooded setting. It is also neat to see a Conrail train several times a day through the rear windows. The terrazzo flooring installed in the lobby in combination with the monumental stairway contribute to an attractive environment for Conrail's employees.

Inside the command center, there is a tiered effect with the rear projection TV screens in the background. It resembles the NASA mission control headquarters but instead of tracking manned space flights, we're tracking the flow of data across our system. There are provisions for numerous additional screens for future expansion. I guess this semi-circular design is impressive, but as I mentioned before, it took a significant effort in all phases of construction to achieve it. This truly is the nerve center of Conrail's business.

Since July, 1993, Conrail has been on line at the new technology center continuously 24 hours a day, seven days a week. We've had commercial power outages, which have gone unnoticed to the operation since backup systems picked up the load. We've had major storms including a tornado which passed through our facility without disrupting operations. We've been hit by lightning a couple of times which has caused us to add some additional surge protection, but from all reports, the facility has been a success and continues to provide Conrail with a platform for future operations well into the next century.

Thank you. (Applause)

President Van Huis: Thank you, George.

At this time I would like to recognize the past presidents in attendance with us today. Would you please rise as I call your names.

Don Steele, Union Pacific, president from 1993 to 1994; Paul Saletnik, Meridian Engineering, president from 1992 to 1993; John Horney, Carter Burgess, president 1990 to 1991; Ray Tallent, Norfolk Southern, president 1988 to 1989; Don Lewis, Illinois Central, president 1987 to 1988; Jim Budzileni, retired Illinois Central, president 1983 to 1984; Wally Sturm, retired EJ&E, president 1978 to 1979.

We continue to thank our past presidents for staying involved and contributing much to our organization.

Let's give these gentlemen a round of applause at this time. (Applause)

At this time, I would like to call Don Steele, immediate past president and chairman of the nominating committee.

Mr. Steele: Thank you, John. To fill positions for directors this year with terms expiring in 1998, the nominating committee has recommended the following:

Willie Benton, engineer structures, Norfolk Southern, Atlanta, Georgia. Richard Calhoun, CTE, Chicago, Illinois. Bill Gemeiner, manager of methods and research, Union Pacific, Omaha, Nebraska.

For senior vice-president, Joe Lileikis, senior engineer structures, Amtrak, Philadelphia, Pennsylvania.

For junior vice-president, Bob Carter, B&B superintendent, Burlington Northern, Springfield, Missouri; and Dave Franz, bridge engineer, Kansas City Southern, Kansas City, Missouri.

For treasurer, Don Lewis, assistant engineer structures, Illinois Central, Chicago, Illinois.

Mike Bradley, project engineer Conrail, Pittsburgh Pennsylvania, automatically assumes the position of president according to the constitution.

Since I have received no other nomination from the membership, I suggest we approve the election of the slate recommended by the nominating committee. Are there any rejections? All in favor? Aye. Any opposed? The Ayes have it.

I have a very distinguished honor here to pass out an award. At last year's conference, Jim Budzileni was elected honorary member. Well, it took a whole year and we finally got everything together and got Jim's honorary membership plaque here. I think it is more fitting to give it in front of the membership instead of just mailing it to him.

Jim, if you would come forward, please. You only have to give a ten-minute speech. (Laughter) I would like to read what the plaque says, "American Railway Bridge and Building Association by this diploma certifies that James Budzileni has been elected as honorary member of this Association and testimony whereof the president and secretary have hereunder affixed their signatures. September 18, 1995."

We welcome you as a honorary member. (Applause)

Mr. Budzileni: Thank you.

President Van Huis: Thank you. We will now begin the report of the Association. We will go to the treasurer's report with Don Lewis.

Mr. Lewis: The treasurer's report for the period September 1, 1994 through August 31, 1995, is as follows:

TREASURER'S CASH STATEMENT

September 1, 1994, Through August 31, 1995

Checking account balance, September 1, 1994		$17,300
RECEIPTS		
Dues	$22,000	
Advertising	12,200	
Bridge inspection seminar	23,300	
Interest on checking account	462	
Miscellaneous	240	58,202
		$75,502
DISBURSEMENTS		
Salaries	$13,817	
Payroll taxes	1,112	
Employee savings	418	
Office rent, utilities, insrnc, taxes	2,870	
Office supplies	222	
Equipment purchase, rent/repair	1,383	
Stationary & printing	3,271	
Postage	2,516	
Conference	2,167	
Information booth for Mini-Show	524	
Proceedings	15,364	
Scholarship fund	2,100	
RT&S subscription	1,853	
Bridge inspection seminars	9,875	
Executive committee meetings	4,776	
Temp. office help & computer cnstlnt.	668	
Miscellaneous	182	63,118
Checking account balance, August 31		$12,384
Funds on deposit - Advance Bank		49,412
Total funds, August 31, 1995		$61,796

President Van Huis: Thank you, Don.
Next we will have Mr. Budzileni give the audit Committee report.
Mr. Budzileni: Thank you, John.

AUDIT COMMITTEE REPORT

To: Members of the Roadmasters and Maintenance of Way Association of America

We, the undersigned members of the Audit Committee, have examined the financial records of the American Railway Bridge and Building Association for the period September 1, 1994, through August 31, 1995, inclusive, and have found them to be correct as of August 31, 1995.

Respectfully submitted,

J.R. Williams
W.G. Sturm
J. Budzileni

President Van Huis: Thank you, Jim.
Next Mrs. Weissmann will present the membership report.
Mrs. Weissmann: The membership report September 1, 1994, through August 31, 1995, is as follows:

MEMBERSHIP REPORT

September 1, 1994, Through August 31, 1995

Total members, September 1			820
New members since September 1			66
Reinstated members			4
			890
Less: Deceased – Active		1	
	Life	4	
	Honorary	1	
Dropped – Active		36	
	Associate	15	
	Life	3	60
Total members, August 31, 1995			830

President Van Huis: Thank you, Pat.
Next Wally Sturm will give us the Necrology Report.

NECROLOGY REPORT

To the President and members of the American Railway Bridge and Building Association:

It is with great grief and regret that we report the known loss of six members through death during the past year. It is possible that other members have passed away during the year of whom we have no information. If you know of any, please report their names to the secretary. The following have been reported since our last annual conference in September of 1994:

			Joined	Died
J.W. DeValle	Chief Engineer, Bridges (Ret) Past President and Honorary Member	Southern Railway	8-3-59	9-8-94
C.E. Dixon	Supvr. B&B (Ret)	Maine Central RR	9-21-55	3-20-95
H.B. Durrant	Asst. Chief Engineer (Ret)	UP RR	9-6-68	3-20-95
M.P. Edwards	Bridge Insp.	IC RR	8-20-91	8-16-95
E.T. Franzen	Chief Engineer, D&C (Ret)	MP RR	2-6-57	5-16-95
I.H. Hawley	Chief Engineer, (Ret)	C&IM RY	12-2-57	3-27-95

Respectfully submitted,

Wally Sturm, Chairman

President Van Huis: Are there any questions of the Association? Thank you.

Mr. Lileikis: I would like to introduce our next presentation on "Trench and Open Shoring," presented by Craig Seery. Craig was recently appointed safety director system engineer on the Burlington Northern. Prior to this most recent assignment, Craig worked as principle safety consultant in the Burlington Northern corporate safety department for the past four years.

Craig has about 16 years of experience in industrial safety, ten of those years spent with different contractors in the Los Angeles area, primarily Hughes Air Craft Company. Craig has a Master degree in industrial safety from West Virginia University and is certified in fire protection engineers from the UCLA University system. He is also a certified safety professional.

It gives me great pleasure to introduce Craig and I ask you to welcome him. (Applause)

COMMITTEE REPORT

TRENCH AND OPEN SHORING

Chairman: Craig Seery, Sfty Dir. Sys. Engr., BN

Co-chairman: Al McNulty, Burlington Northern

In Quarter I, 1990, the amended 29 CFR part 1926, Construction Standards - Subpart P Excavations, was promulgated. This amendment was deemed necessary, despite the existing 1971 and 1972 OSHA Construction Standards, excavation related injuries/fatalities continued.

Additionally, in some cases wording in the existing standards was found to be too general and ambiguous. This problem sometimes led to difficulties in making clear interpretations.

Excavation work is one of the more hazardous construction activities. Accidents occur more frequently in excavation work than in construction in general.

A OSHA study completed in the 1980s found that an average of 97 persons/year died in excavation related accidents. Of these, 73 persons/year died as a result of cave-ins.

A 1980s study completed in California found a ratio of non-fatal, lost time injuries to fatalities of 50 to 1 for excavation related activities. This ratio is to be compared to a ratio of 174 to 1 for construction related activities in general.

The major hazards of excavation work are: cave-ins, exposure to underground utilities, and exposure to materials and equipment falling into an excavation.

Appropriate preparation efforts in the form of pre-job planning and job briefings is the best way to address the concerns and hazards faced in excavation activities. Proper preparation also helps a project to be completed in an efficient manner.

To help ensure that safety and health considerations are addressed during all phases of an excavation project, including the preparation phase, OSHA requires employees to make competent persons available at excavation projects. Competent persons are to be capable of identifying existing and potential hazards, as well as unsafe working conditions. It is also required, and is critical, that on-site competent persons have the authority to take prompt corrective measures to eliminate hazards and unsafe conditions.

Some employers may elect to train all employees who participate in excavation activities to the level of competent person. Other employers may select a core group of employees to be trained as competent persons.

One of the initial considerations during the project preparation phase is soil classification. Appendix A to Subpart P of 1926 contains specifications and information for making determinations as to soil classification. The soil categories are Stable Rock, Type A Soil, Type B Soil, and Type C Soil. Soils classifications are to be made by a competent person.

Previously disturbed soils, as commonly found on railroad property, would be categorized as Type B or Type C Soil, depending on the characteristics of the soil and the results of analysis. Some employers may elect to assume, with the exception of major projects, that all of their excavation work involves Type C Soil. The protective systems requirements for Type C Soil are the most stringent.

The primary hazard encountered during excavation work is cave-ins. To address cave-in concerns, protective systems need to be employed. Examples of protective systems are sloping, benching, shield systems and support systems. Protective systems prevent materials from falling or rolling in the excavation face or into the excavation. Protective systems are required for trenches five feet or more in depth, as well as in trenches less than five feet in depth where soil is unstable. Specific information and requirements relating to protective systems is found in the appendices to Subpart P.

One specific area requiring additional extra attention in regard to employee safety is the

installation and removal of shoring systems. Install shoring systems prior to entry, and as soon after excavating as possible. Installation should be completed from outside the excavation to the extent possible. Tabulated data for shoring systems needs to be maintained at the job site.

Remove shoring from the bottom up. Workers removing shoring need to remain in a protected zone. Hydraulic shoring should be removed from outside the excavation. Be sure to promptly backfill an excavation after removal of a shoring system.

Consider the potential for exposure to underground utilities prior to excavating. Refer to site plans as well as any as-built drawings that would show utility locations. Outside utility location services also need to be contacted as appropriate.

Confined space concerns need to be addressed when preparing to perform excavation work. Requirements relating to confined spaces are found in 29 CFR 1910.146; Permit-Required Confined Spaces. Trenches and pit-type excavations of four feet or more in depth are when confined space issues are most likely to be of concern.

A confined space is defined as a space that:

- is large enough and so configured that a worker can bodily enter and perform assigned work; and
- has limited or restricted means for entry or exit; and
- is not designed or intended for continuous occupancy by personnel.

A subset of the term confined spaces is the term permit-required confined space. A permit-required confined space is defined as a confined space that has one or more of the below-listed characteristics:

- contains or has the potential to contain a hazardous atmosphere;
- contains a material that has the potential for engulfing an entrant;
- has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers or a smaller cross-section; or
- During the course of a project, weather conditions may affect the excavation. Excessive water may liquefy soil, thus increasing the pressure on protective systems. Frozen soil can undermine a shoring system. When developing a project time line, consider the potential for delays caused by adverse weather conditions.

Vibration is another example of factors to be considered during the preparation phase. Vibration from machinery, explosives, or traffic on nearby roadways increases loads on shoring systems, and also may allow material to fall into the excavation.

Be sure to locate your spoils bank away from the immediate work area or consider the additional weight of the spoils bank when calculating surcharge load.

Some form of edge protection needs to be provided at excavation sites. Take appropriate precautions to prevent machinery, equipment, tools, and excavation materials from falling into the excavation. Consider erecting barricades, fencing or warning tape for worker and pedestrian protection. Instruct workers to avoid walking along the edges of excavation. Provide an adequate number of crossovers at trench excavations.

An adequate means of access/egress needs to be provided every 25 feet at trench excavations four feet or more in depth. Ladders are most commonly used to meet this requirement. Ladders need to be inspected prior to being placed into service and at appropriate intervals thereafter. Secure ladders from movement and extend side rails three feet beyond the lip of a trench.

Finally, in regards to project preparation, plan for emergencies. Emergency preparedness cannot be overlooked or minimized. Determine the locations of the nearest emergency responders for fire, medical and police services. Determine telephone numbers and estimated response times. Also, identify workers on a project who have current status in CPR and/or first aid training.

To help ensure worker safety during the course of a job, periodic inspections are performed by the competent person. Daily inspections are conducted prior to the start of work and as deemed necessary throughout a shift. Specifically, additional inspections should be conducted after rainstorms or other changes in conditions that increase cave-in possibilities. For the excavation itself, protective systems and areas adjacent to the excavation are all to be evaluated during these inspections.

Finally, make sure that you have the ability, equipment, and time to adjust to changes such as deterioration of the excavation due to the adverse affects of water intrusion or adverse weather conditions, et cetera. Again, anticipate and plan for changes.

In summary, three key factors have been identified as critical to the safe performance of excavation activities: preparation, on-going inspections, and the ability to adjust to changes. Satisfactorily addressing these factors will help to ensure that your project is completed in a safe and efficient manner.

If there are no questions, I will see you in a year. (Applause)

Mr. Lileikis: Thank you, Craig.

Our next feature is "Cast-In-Place and Segmental Post Tensioned Railroad Bridges" and the presenter is David Levy from Frederic R. Harris.

Dave Levy received a Bachelor of Science degree in engineering from Cooper Union in 1974. Dave then spent eight years with the New York City Transit Authority in the track and structures department before working two years as a general superintendent for a bridge contractor. Since 1985, Dave has been employed with Frederic R. Harris Incorporated, a consulting engineering firm. Clients have included the Long Island Railroad, Metro North, and the North San Diego Transit.

In addition, Dave has been engineer of record for a majority of the Metrolink computer rail projects in southern California. Dave is a professional engineer in both New York and California. Please welcome Dave. (Applause)

CAST-IN-PLACE AND SEGMENTAL POST TENSIONED RAILROAD BRIDGES

David Levy

Vice President
Frederic R. Harris

Good afternoon. Our subject is concrete bridge construction techniques in California.

Let's first go back and discuss some railroad bridge types. Traditionally, the first type of bridge was steel thru-girder used very effectively throughout the life of railroads and, of course, had the great advantages of long spans and the lowest distance between the top of the rail and the soffit of the bridge. It was also a great advantage to grade crossings. Another type, of course, is the bridge steel deck which offers the advantage of redundancy and is more economical than a thru-girder. It also offers the advantage of using track centers and crossovers on a bridge deck.

In California, we use concrete construction and there are two types used. Traditionally, the railroads use precast box girders as shown here. They have advantages of speedy construction, simple construction, are widely used and a proven technology. You can stockpile girders and precast bents which are very effective for short spans. The highway departments and CalTran use a different kind of construction. They use a trapezoidal cast-in-place post-tensioned box girder. It offers the advantage of simple construction and is very cost effective.

I want to explain our problem in justification in using this type. When we came to build the commuter rail properties in California all our construction cast was done by third parties. So we thought it was to the best advantage of everyone that we design a bridge structure consistent with CalTran so that the contractor would be familiar with the type of construction and bid accordingly. To our great surprise, we found the steel is more than two times as expensive as concrete per square foot basis. I think that's rather exaggerated compared to the rest of the country. We had to acknowledge that and move forward with that in mind. In the beginning of our bridge program we investigated simple spans versus continuous spans. Prestressed or post-tensioned concrete versus simple reinforced concrete. We chose cast-in-place post tension and we will show you why in a moment.

In addition, we had to design for earthquake requirements. Continuous span post-tensioned offered a lot of advantages for earthquake requirements. At the end of our presentation, we are going to show you a long span, we built for a transit property. We used a segmented design over the L.A. River. On that particular job, we built it during the California wet season. We couldn't use any scaffolding over the L.A. River. We had to build a 450-foot span without scaffolding and post tensioning details became extremely important.

Let's talk about simple span versus continuous span. Before I begin, I have to offer an apology. We tried to produce a high tech presentation. We had this new computer to bring in autocad software and show you our drawings and how we created them. However, I was the guinea pig in the office for the software and it didn't really work. So we are going to have some view graphs intertwined with slides.

That is supposed to be a simple span. If we have two simple spans of 75 feet or an equivalent E80 railroad loading, we have a depth of about five feet for trapezoidal section. For continuous span for two 75-foot spans, the depth could be reduced to four foot three with obvious savings of concrete. In addition, with seismic loading, if the bridge superstructure were to move in a longitudinal direction, the two abutments would have to restrain all the force. With the center fixed connection at the center pier, that pier could also be used to absorb some of that earthquake force.

Comparing the two simple spans versus a continuous span, you see the depth is five feet versus four foot three inches for the simple span. For the simple span we need a weight of superstructure of 6,000 pounds per linear foot versus continuous 5,000. The numbers are just juxtapositioned. For the simple span we should have $1,700 per linear foot cost of construction versus $1,400 linear foot cost of construction. So this shows a continuous span has a cost savings of $300 per linear foot for a 20-foot wide deck for the superstructure only. Post-tensioned concrete versus reinforced concrete. First, on the reinforced concrete we would see a span of eight foot depth for this equivalent loading. Here we are down to five feet for this equivalent loading. A comparison would show the weight of the superstructure for the post-tensioned is 6,000. For the reinforced concrete alone it is 9,200. Therefore the cost is $1,700 per linear foot versus $2,000 per linear feet.

Here is a comparison for a 150-foot long span. Two spans of 7,500 foot each. The simple span reinforced would cost roughly $2,000 a linear foot. Continuous span non post-tensioned $1,700 per linear foot and a continuous span post-tensioned of $1,400 per linear foot. So clearly there is a savings in accepting the design of post-tensioned continuous span. Cast-in-place concrete post-tensioned concrete construction. I would like to review a typical

section of elevation, false work, and form work, post tensioning, tensioning systems, and then touch on seismic design. On a typical section it is important to recognize the section is poured in two pours. You have the bottom flanges and most of the two vertical webs which are trapezoidal. See the number eight bar typical design and a construction joint that is always stepped for sheer and you notice the decks that are longitudinal post tensioning.

Here is an elevation where you have the post tension and it's parabolic at this center curve and it's vertical in between. It's hard to make those exact parabolic curves. You will see later the amount of rebar in California construction for earthquake resistance is extensive. It is tough to make those strands, but we do get them in.

Here is a view of our Metrolink train running over a trapezoidal section. This is a fly over in El Monte, California, where we are parallel to the SP track and had to fly over it. You can see the existing steel thru-girder at a lower elevation that is over the San Gabriel River.

Here is a view from underneath. You can see the straddle bents and they were also post-tensioned.

Here we show how to form and pour. Notice for the bottom flange there is a concrete block. You pour both the bottom flange and the two webbings. First you pour the deck but it's still in a wet joint. You pour the flange. You have concrete blocks inside the pour to support the former. We will show them later on. You have to be careful when you vibrate the concrete that you don't vibrate too close to the toe of the vertical wall with the flange because you actually can vibrate a little bit of concrete out of the web and therefore create voids. You probably won't notice it on top of the form because of the excessive rebar. Then you complete your pour with the top flange. It is quite heavy up the overhang form work for your catwalk, et cetera, when you do.

Safety is, of course, the first concern. The form work must have the safety rail, et cetera. The extensive grillage is present and the extensive steel to support this form work.

These are steel longitudinal beams and a steel vertical beam that supports the form wear. I believe a lot of this was developed because of CalTran's highway overpass design which minimizes form work depth and allows the new overpasses to be built over the interstate system. Being in southern California, we do what southern Californians do.

Here we see a picture of the bottom flange and the two webs being readied for pour. You can see at the bents the diaphragm steel.

Here is a picture of the bulkhead being formed and the ducts for the post tensioning. Here is the steel going in. Notice the higher amount of steel at the diaphragm. Later on, we will show the columns are tied together.

Here are the post-tensioning strands. They are seven wire strands and this was incorrect. The strands should always be placed into the duct after all the work is done so they are not subjected to any damage or nicking which is possible. We made the contractor remove these strands and place the ducts in and we re-installed the strands later on.

Here is a view of the web. Again, there's quite an extensive amount of form work. Perhaps you can see the concrete blocks that are all used to support this kicker that support the vertical form work.

Here you see the deck ready for pour before the rebar is placed. Here you see the extensive amount of rebar in the deck.

On this particular bridge, which was a 3,000 foot long viaduct, the span averaged about 90 feet. The entire deck was poured at once. We have the concrete pump pouring the concrete. It took quite a bit of time. It took about eight hours to make the whole pour. There were about four or five pumps going simultaneously and they really cranked it out so it was really quite successful.

This is your typical false work. Again, the California excessive way, you can see the high supporting grillage that we showed up on top. There was an excessive amount of timber bracing recommended that you can have a 30 or 40-foot high structure with a big mass on the

top for earthquake resistance. The bracing is quite extensive. CalTran required that this be signed off by a professional engineer.

At the bottom, of course, there was excessive grillage. You have some welding details for the metal connectors.

Here we see the supports — the heavy steel beams going across and a lot of columns. There was an extensive amount of columns false work support and their cross bracing.

Because of seismic concerns you can see that the cross bracing is bolted. They are pretty strong bolts to the main posting. This is the San Bernardino fly over the Metrolink over the Santa Fe mainline at the San Bernardino yards. On one of these bridges, the SP fly over, a major earthquake occurred measuring 7.1. I went out to inspect the form work about two hours after the earthquake and everything stood up very well. Of course, this is typical for timber construction. It does absorb shock quite well. But there you can see on the bottom extensive grillage and this is more or less similar to all standards forms of posting false work. I think California is a little more excessive than most.

Here you have an underview of it. This is the SP fly over. Again, you can see an extensive amount of form work required. We put up tell tales to alert any trains carrying a wide load not to wreck the form work about 1,000 feet away. We had no incidents affecting that during the life of the project. There is a MSE, mechanical stabilized earth wall. In an earthquake environment, that is one of the more favorable walls. It is light weight and it does absorb shock. It dissipates the energy and if any settlement occurs, it just rearranges itself through the stretching of the tendons to maintain the tension of the tendons to prevent the wall from collapsing. It is a very economical and successful design.

Let's talk a moment about the post-tensioning system. Post tension requires ducts, seven strands high-strength wire. They have to be careful. You can't drag it over rebar. This will be nicked and therefore the duct system must go in first.

Here's an extensive use of a hydraulic jack system to tension these cables. That requires a strong anchorage system with a bearing plate and bursting reinforcement.

This is the "trumpet." It is a device that is used to insert into the bulkhead to accept the strand before they are tensioned.

There is an anchorage and bearing plate. You can imagine the pressure on the bearing plate. There is a rigid duct and you will see a picture of it. A strong amount of spiral reinforcement to prevent this trumpet from being pushed up against the concrete and bursting out of the concrete.

Here's a diagram of the "trumpet" assembled. You can notice that over here is a lifting frame. It is quite heavy and there is a hydraulic jack that is going to tension the cables. You have to leave enough room for the jack stroke to allow it to come out. This means that decks are always tensioned before the pour of the diaphragm of the bents.

Here you see the buckets that will carry the ducts that will carry the strands. Notice how they are crossing over the bent cap. Notice the excessive amount of rebar in the diaphragm. This top steel is just a maze of steel and it forms the parabolic curve as it goes down.

Here it is going over the bents in a negative movement. Here is a view of the bulkhead after the forms were stripped on the previous one. You can see up here the little lifting device that brings down the pusher. We push cables through the ducts to the other side. You would think we would pull them, but they are best pushed. There is a little motor that pushes these through these two ties to feather them in. It works quite successfully.

The duct is being extended out for that. First of all, notice the little recess in the concrete. That is to allow space for the jackets to have enough room to tension the cables. After this the next pour will be the next beam. Again, a four-span length and then pouring the diaphragm. This little pour hole allows a man to come through a manhole through the deck and access work to tie up the rebar for the diaphragm.

Here you see the deck getting ready for tensioning. This is a view from a different

bridge where there was a lot of tensioning ducts available. The jack weighs an estimated 1,000 pounds. It is quite heavy and it pulls out with 150 or 200 tons per cable per strand to put them through. So it is quite a tensioning device.

Let's touch a moment on seismic design. California has those problems and there are some design issues and construction details that go along with it, such as seismic design loading. Let me take a minute and just explain what seismic loading is. The earth moves and we all know that the bedrock slips on fault lines and this causes the earthquake. To an engineer, what this means is that the bedrock moves and drags the topsoil or anything else along with it. Consider that you have a substructure of pile foundation. If the earth moves, the pile foundation goes with it. Since F equals MA and the acceleration of the earthquake could be about .5G or more, then the connection between the foundation and the superstructure must be strong enough to resist this load. The way we define the intensity of the seismic loading is we define the seismicity location to fault lines, soil conditions, et cetera. Locate the fault in the distance to the site. You analyze the fault threat. This is an important concern.

No one can design a structure to resist the highest credible earthquake. You have to design the bridge for the amount of the risk that you want to take. You analyze the fault threat accordingly. You establish the maximum credible earthquake which is based on statistical analysis done usually by CalTran with information supported. For special structures, they do a special evaluation for credible earthquakes established. Based on a bunch of data collected in California, CalTran establishes the credible earthquake. Then you establish the maximum acceleration.

When the earthquake force is transmitted through the soil, funny things happen. In some places the energy is dissipated and in some particular cases it's actually accelerated. In the last Northridge earthquake, the maximum damage occurred within a few miles of the epicenter in Northridge but the next most intense section or location of damage was about 50 miles away in Santa Monica. A lot of it had to do with the soil conditions that magnified the seismic loading.

Once you have completed the design to define the seismic loading on the structure, determine distance to the bedrock, and calculate the peak loading spectrum. This is just a simple formula and a simple graph that we laid the structure period to the ARS and from it most of the bridges occur in this range. We would get a load somewhere between .8 and 1.2. The seismic load equals the ARS of .8 or 1.2 or 2.2 of the dead loads. We must apply that in the transverse direction, the longitudinal direction, and the vertical direction. The requirement for combining the loads is you must apply the worst case of all three cases. What this means is that you must take 1.0 times the transverse loading, .3 times the longitudinal load, 73 times the longitudinal loading, .3 times the vertical loading or the ARS that is predetermined. Let's just say it is equal to the actual dead weight.

What we do is we assume a force being applied in the transverse direction to the structure of equal to its dead weight, .3 in the longitudinal direction, and .3 in the vertical direction. Each component of the bridge must be analyzed for this case. Similarly, each component of the bridge must be analyzed with this distribution of stresses. Notice this last term. This can be mean in the transverse or longitudinal, any one of the two directions plus or minus depending on your orientation. This means you might have an upward force acting on the structure of one. To remain attached to pile foundation there has to be a strong tension between the piles and the structure at the footing.

In addition, short piles resting on hard rock will not warp. There will not be enough skid friction to resist a vertical load and the piles will actually separate from the structure.

Now I want to show some detail on how we apply the seismic loading. The key things are the connection of the pile to the pile cap. You have to provide top reinforcement because of the negative bending of the pile cap. Because the negative bending can be so excessive usually the minimum size bar utilizes the number 11 and very common number 14 and

number 18 because the pile cap might be economical seven or eight or ten feet in diameter. A lot of times, as you thicken the pile caps, the most economical use is to allow the bending of the hook to produce a development length. Because the top steel and the bottom steel is so far apart, you have to insert stirrups. That is a code requirement. You must apply stirrups at each location at every top and bottom bar. Again, you bed the pile to develop upward capacity.

Here we see some small cast-in-place piles and here you see a completed assembly of the vertical connection to the pile cap. I think this is about 50 percent heavier than it would be in non-seismic territory.

Here we see the column. The column you will see becomes extremely heavy in steel. If you can find the longitudinal steel with the heavy duty spiral, it has been found that in the last two earthquakes, especially the one in San Francisco in 1989, that the spiral steel was not sufficient. The concrete burst and so they now increase the amount of spiral. You try your best to eliminate lap splices and spiral in the longitudinal steel. If you have to use mechanical supplies or weld it, you develop the column steel into the pile cap in diaphragm.

Here you see a picture of the heavy top and bottom steel. The pile cap is rather excessive in depth. The stirrups tie the top steel to the bottom steel. There are a couple of mechanical splices in there. There is a pier that requires three bound columns. You can see excessive amount of steel again spiraling and see the steel anchor into the pile bents cap up on top.

Here is assemblage again of these three spiral bound columns for a large pier. This form work out here is for crash wall. This is for the Santa Fe fly over in San Bernardino. As you can imagine, getting the concrete in amongst all the steel is a very important concern. We had to specify pea gravel many times and we had to vibrate excessively. On long deep shaft cast-in-place, we do connect and X-ray testing to make sure there are no voids.

Here you see the reinforcement at the bent. You can see columns come in and the spirals going around as the columns come up into the diagram.

I want to touch a minute on segmented construction. It's a new construction. I never did it before and I found it very interesting and very different. You begin the process by building two piers and this we call cantileving construction. There is no false work to support the beams and they are going to extend in both directions.

They will build this over false work because this is over land. Over the river it would be built without false work.

Here is the false work that will support the other section. It has to be cantilevered because the column cannot resist all the weight in one direction.

Here is a picture of the column; the section that was cast-in-place.

Here is the rail that anchors it.

Here is the form that extended out. This device is two steel frames but they use wood form work in between the steel frames leveled up and bolted into place and the wood form work is cut into shape to form the curve of the bridge deck.

Here is the rail that supports this section of the core pour.

Here are the extension pieces. This again is all cut into place.

Here is the bottom steel. Inside there are cables supporting this and holding it up. Then we continue out and aim for the center section. Again, it has to be cantilevered to balance it.

In extending out, you can notice that the depth of the section is changing. That is because obviously the movement is the smallest in the middle and to save the weight the form, of course, is adjusted to shape.

This is over the L.A. River in downtown Los Angeles.

Here is another view of the two coming together. It's an interesting view of us looking at the form. As we come together, we finally have to remove one particular of the traveler form and too tight of a condition and just pour one less section. Before we pour the last section, because of all this weight and the depth of this section compared to this, the columns have a tendency to restate inwards. We apply 2,000 kip jack to the structure to push back into

neutral position. They put up laser reflectors on the towers noticing not a deflection in and then jacked it back into place. I thought it would be a very difficult thing to do. It was quite easy to do.

Here is just a detail, the truss to support the outline section, and bottom form support platform. The flange of the segmented section must be designed to resist to hold up this weight which actually is not that excessive. It is only a 15 foot section. It goes pretty easy if you have a guide rail.

Here we are closing up. We still have two forms on. This is the last pour we can make with two forms. Then we had to go to one form and then we had to jack. The concrete pours were relatively simple in size and they weren't much of a problem. Here is a closeup of the jack and the torch carriage. That is actually the cables that support the lower section. You can see the cables coming down and they can winch them up.

How does cantilever construction work? Here you see all these different sections. There are 14 to the mid span on this particular bridge. After this first one is poured, there is a sheer key at the connection, cables are installed, and tension to connect this section to this section. When you pour section three cables are installed from section one through to section three and they're tensioned so all three sections are now acting in unison. These cables are just for erection purposes. After you are done you have another set of cables that tension the bridge for the loading.

You can see here in the early part of the section how many cables there are to constantly go through the pours. This is about the second pour and all this duct work is put in many cables and many different pours.

Here is a view of the bulkhead and the many cables that are coming through. Obviously those cables have to be anchored in excessive amounts of stirrups and we didn't use "trumpet" here. We actually had a steel "trumpet" because of the size of the pull. This is to give you an idea of the amount of rebar required and hopefully it all works and we get a train running on time.

I want to thank a few people in the audience for their help in working on the project. Ken Koff, Keith Pottorff and Mike McGinley. They all worked on Metro Link. It was a $450 million capital improvement program completed in three years. We are very proud of the project. Thank you very much. (Applause)

Mr. Lileikis: Mr. Levy, thank you very much. I would like to give you a token of our appreciation.

Our next presentation is a Brief History of Movable Railway Bridges. It's going to be presented by Rick Calhoun. Rick has an interest in movable and historical bridges and railroads and as a result has accumulated many photos and various details over the last 21 years.

He does have over 21 years experience in the design, inspection and construction of structures. He has inspected, rehabilitated, and designed numerous movable bridges. If I am not mistaken, a few years back when we had our conference in Chicago at the Westin, the Michigan Avenue Bridge bascule collapsed and Rick was sent out to take a look at it.

He was the project manager for the recently completed new CSX bascule bridge in Pascagoula, Mississippi. Rick is a member of the B&B Association, AREA Committee 15 "Steel Structures" and a member of the subcommittee on movable bridges.

He graduated from Michigan State University in 1974 and is a registered Professional Engineer in 11 states. Rick is an Associate with CTE Engineers in Chicago. Please welcome Rick Calhoun. (Applause)

A BRIEF HISTORY OF MOVABLE RAILWAY BRIDGES

Richard Calhoun

Associate
CTE Engineers, Inc.

Since the introduction of the railway in America in the late 1820s, a problem has plagued the industry: How to cross navigable rivers without restricting waterway traffic, without using long elevated structures, or without using steep grades. The answer: A movable bridge.

Prior to 1840, most railroads were truly short lines, haphazardly planned and constructed utilizing their own standards and most not exceeding more than 150 miles of trackage. These early railroads were primarily in direct competition with the numerous canal and riverboat companies. Many early crossings of major rivers utilized wooden barges to transfer the trains or cargo from shore to shore. By 1860, there were more than 200 railroads operating in the United States, mostly east of the Mississippi River.

Wood was the material of choice for bridge construction in the early years of the railroads. It was plentiful and easily worked for trestles and short spans. However, as the railroads expanded westward, wider rivers were encountered requiring longer spans. Trains were also getting heavier. Stronger materials needed to be found. The first bridge to be constructed of a material other than stone or wood was constructed in 1779 at Coalbrookdale, England, using cast iron. The first bridge in the United States to use cast iron was designed by Richard Delafield and constructed in 1839 at Brownsville, Pennsylvania, over a tributary of the Monongahela River. In 1845, the first all-iron railway bridge was constructed near Philadelphia for the Philadelphia and Reading Railroad. By 1852, wrought-iron eye-bars were being used for truss bridges on the Baltimore & Ohio Railroad.

The use of cast-iron as a bridge material was forever changed in December 1876 when the cast-iron truss bridge over the Ashtabula River in Ohio, constructed in 1865, collapsed as an eleven-car westbound train of the Lake Shore and Southern Michigan Railroad was crossing it, killing 92 people. Unfortunately, a stronger material, open-hearth steel, had been successfully used for more than two years in bridge construction at the time of the Ashtabula accident.

The first all-steel bridge in the United States was constructed across the Mississippi River at St. Louis in 1874. The bridge, designed by James B. Eads, carried two lanes of highway traffic on an upper level and two tracks for rail traffic on the lower level. The historic Eads bridge is still in service today. The various movable bridges followed this same progression of construction materials, often using a combination of materials such as wood and cast-iron, cast-iron and wrought-iron, or steel and wrought-iron.

Movable bridges can be separated into three general categories; swing spans, vertical-lift spans, and bascule spans. The original concepts for movable bridges are largely attributed to Leonardo da Vinci (1452 - 1519). About the year 1500, the scientific genius da Vinci made conceptual sketches of swing span and pontoon bridges and theorized the use of trunnion bascule and vertical-lift bridges.

General Features of Movable Bridges

Low-level bridges are more susceptible to damage from river traffic than high-level structures; that's why they're made movable. Compared with high-level bridges, the movable spans are also much more costly to maintain. All movable bridges require operating

machinery, controls, and movable rail joints which must be maintained and often rehabilitated or replaced prior to replacing the bridge itself. All three types require centering devices to ensure that the rail joint castings are properly aligned when the span is closed.

Bascule and vertical-lift spans also require air buffers or shock absorbers to lessen the impact of seating the movable leaf. Both types also require span locks. In most cases, electrical power and signal circuitry must be provided across the navigation channel, either through submarine cables or overhead catenary wires. Navigation lights and fender systems are also needed to protect the bridge and substructures.

Each movable span must also be balanced to keep the machinery and structure operating efficiently. The American Railway Engineering Association (AREA) recommends that one percent of the counterweight be adjustable. This allows the movable span to be fine-tuned and compensates for changes in the weight and balance of the span, such as differences between older and newer ties. Around 1910, counterweights began to be constructed of concrete rather than cast-iron and a considerable savings in costs was achieved. However, the size of the counterweights nearly doubled, even with the use of steel punching in the concrete mix.

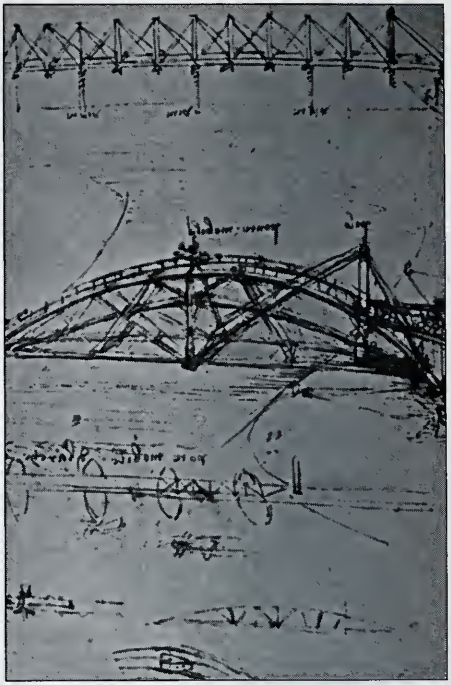


FIGURE 1 – Swing-Span Bridge Concept by Leonardo da Vinci in 1500

Swing Spans

Swing spans were the first movable bridges used for railway traffic across navigable waterways. The span pivots on a vertical axis with equal length cantilevered arms or unequal cantilevered arms with a counterweight on the shorter "bob-tail" end. The earliest swing-spans were operated by horse-drawn ropes attached to the span and later by steam engines and then by electric motors. Most swing-spans today are rotated by a pair of spur gears, driven by vertical shafts and machinery located on the movable span. The pinions operate against a fixed circular rack gear attached to the top of the pivot pier. When the span is closed (open for rail traffic) end wedges are driven at the supports to prevent deflection of the cantilevered arms and provide restraints against lateral displacement at the rest piers.

In the early years of movable bridges, a favorite past-time of children was to "take a ride on the bridge." Hopefully such thrills have now been replaced by amusement parks.

Swing-span bridges can be divided into two operational types; center-bearing and rim-bearing spans. These types refer to the means of supporting the swing-span while it is rotating. The center-bearing type utilizes flat or concave steel and convex bronze discs, restrained against lateral displacement. Figure 2. When the bridge is closed, wedges are driven between the underside of the bridge near the center bearing and the top of the pivot pier to prevent live loads on the center bearing.

The rim-bearing type utilizes a series on conical rollers bearing against a track plate on the pivot pier and the underside of a circular carrying girder. The rim-bearing type is restrained against lateral displacement with the use of a large diameter pin at the center of rotation. The rim-bearing wheels and circular girder are designed to withstand the dead loads and live loads on the structure.

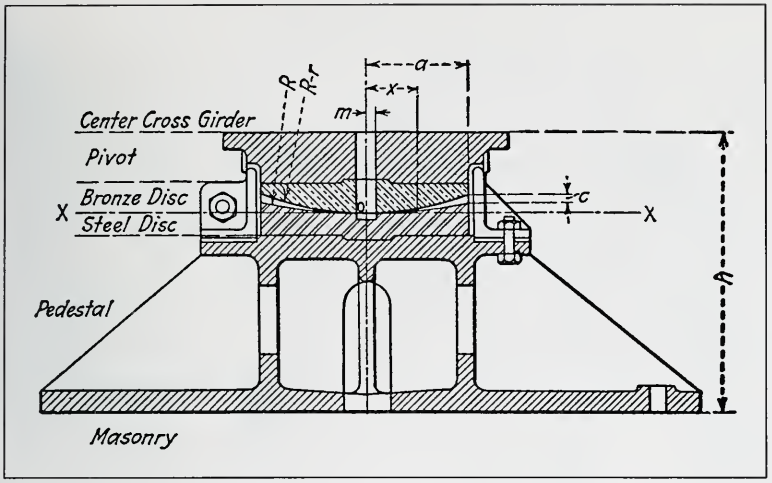


FIGURE 2

Center Bearing Detail

Most of the early swing-spans utilized the center-bearing type. Of all the types of movable bridges, the swing-span bridge is also the most vulnerable to river traffic when open. Today there are 310 swing-span bridges operating in the United States that carry railroad traffic.

A third type of swing-span combines the center-bearing and balance wheels. This group includes turntables which many railroads still use at their maintenance facilities. These structures are normally center-bearing, deck girder or through-girder spans, 75 to 125 feet in length. Unlike the previous swing-spans, there are no end wedges or lift rails at each end of the structure which is normally rotated using machinery and drive wheels at one or both ends of the span. A common problem with these structures is the center bearing which is normally not designed for lateral loads, such as braking of the engine.

Vertical-Lift Spans

Vertical-lift spans consist of a horizontal span positioned between two stationary towers. The movable span is lifted vertically by wire ropes attached to each end of the span. The lifting ropes are passed over large diameter sheaves at the top of the lifting towers and attached to counterweights equal to the dead weight of the lifted span.

The first vertical-lift bridges in the United States were constructed in the 1870s to carry pedestrian and horse-drawn traffic across canals in New York State. These spans were less than 50 feet in length and had a lift of less than 15 feet. The first significant vertical-lift bridge was designed by Dr. John Alexander Lowell Waddell (1854 - 1938). Dr. Waddell designed a steel vertical-lift bridge to provide an approximate 100 feet wide navigation channel and 155 feet vertical clearance in the open position. The structure, completed in 1894 across the Chicago River, carried both vehicular and two tracks for street car traffic.

Vertical lift spans can be divided into two separate operational types: The span drive and the direct or tower drive. The span driven structures have the operating machinery mounted on the moving span. As illustrated in Figure 3, up haul and down haul wire ropes either pull the span up or down. These operating ropes are wound on drums which are turned by the operating machinery.

More recently, tower driven spans have been built. These structures are so named because the operating machinery is located at the top of each lifting tower. Motors and gear reduction provide power directly to the lifting sheaves, eliminating the need for up haul and down haul ropes. Electronic devices maintain the lift span in a level position during raising and lowering.

With longer lift spans and higher lifts, a means of reducing the unbalanced load of the

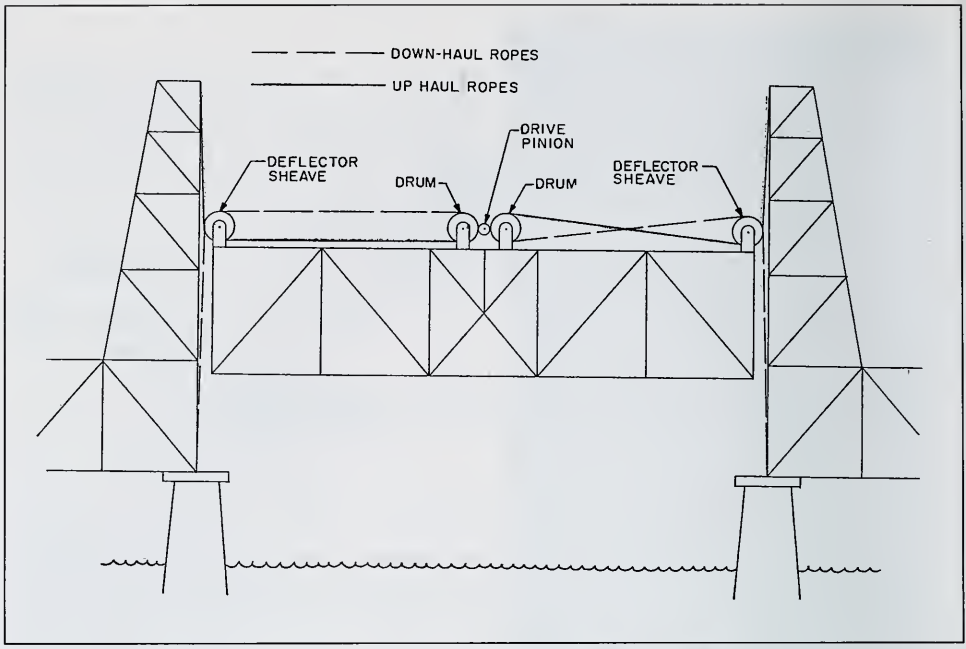


FIGURE 3 – Up-Haul and Down-Haul Ropes

lifting ropes was needed. Balance chains are used to compensate for the weight of the lifting ropes as they pass over the sheaves while the span is being raised and lower. A typical lift span may require as many as 12 lifting ropes per sheave and have a lift of 60 feet. If the weight of the lifting ropes is six pounds per lineal foot, this is an additional unbalanced load of nearly 4,500 pounds per sheave. The lift span is also restrained against lateral movement, as it is lifted, with the use of span guides which are normally designed to bear against a track attached to the legs of the lifting towers.

Since the original 1894 vertical-lift span, many bridges of this type have been constructed. For navigation channels over 180 feet wide, it is the most economic type of movable span. Today there are 108 vertical-lift spans operating in the United States which carry railroad traffic. These range from the bridge over the Cape Cod Canal in Massachusetts, constructed in 1935 with a 500 foot navigation channel to smaller spans with less then 60 feet of navigation clearance. In recent years, vertical-lift spans have been used more frequently to replace older swing spans and bascule spans to provide wider navigation channels.

Bascule Spans

Bascule spans are the most diverse group of movable bridges. The origin of the bascule bridge dates back to medieval times when draw bridges across moats were used to safeguard castles. The balanced bascule leaf pivots on a horizontal axis, the basic concepts of which have changed little in the past several hundred years. One of the early advocates of bascule bridges argued that where several tracks must cross a river in close proximity, swing spans were certainly not the most efficient.

The earliest known bascule bride for railway use was constructed in 1839 for the North Eastern Railway at Selby, England. A wooden bascule bridge was constructed in 1864 for the U.S. Military Railroad across the Tennessee River.

The modern bascule bridge was reintroduced in the United States with a design by William Scherzer (1858 - 1893) and patented by his brother Albert H. Scherzer (1865 - 1916) in 1894. This style of bascule bridge became known as a rolling-lift bascule bridge. The first

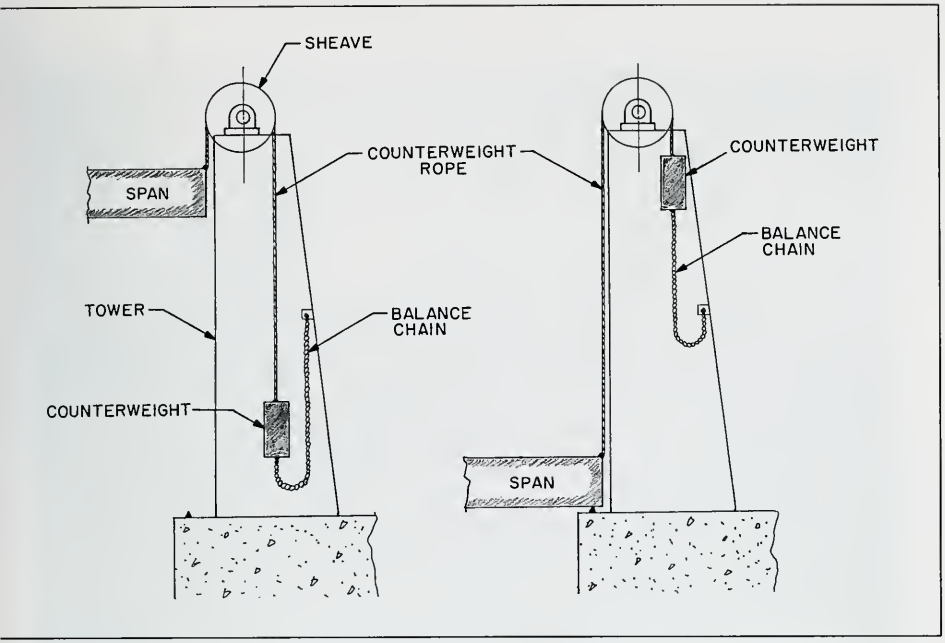


FIGURE 4 – Operation of Balance Chains

steel rolling-lift bridge was a double-track, double-leaf bascule constructed in 1895 for the Metropolitan West Side Railway across the Chicago River. Each leaf of the rolling-lift bascule bridge rolls back, similar to a rocking chair as it opens. Because of the nature of the rolling-lift bascule, in most cases the operating machinery is mounted on the moving leaf. The machinery operates a pinion which acts against a stationary horizontal rack gear to roll the leaf open and closed.

There are a rolling-lift bascules which are chain operated with the machinery located beneath the fixed approach span. There is also a bascule with stationary operating located in the adjacent operator house and a sliding bevel-gear transmitting power to the operating pinion on the moving leaf.

A variation of the rolling-lift bascule bridge was designed and patented in 1901 by Theodore Rall. As seen in Figure 5, the Rall type bascule bridge utilized cast steel rollers, approximately 56 inches in diameter with a 25-inch face, to support the bascule leaf as it was pulled opened by an operating strut.

The moving leaf rolls on the cast steel wheels which are supported by heavy double-web girders. In the closed position, the lower swing strut raises the bascule leaf such that the live load stresses are not taken by the steel rollers. The first bridge of this type was a single track structure with an approximate span of 26 feet constructed in 1901 for the Pittsburgh, Fort Wayne and Chicago Railway over the Miami and Erie Canal. The Peoria and Pekin Union Railroad operated a single-track, double-leaf Rall Type bascule bridge, constructed in 1914, until it was replaced in 1984 with a vertical-lift span. One of the few Rall Type bascule bridges still in operation is the double-leaf highway bascule with a 250 foot navigation channel constructed in 1913 at Portland, Oregon.

In 1902, John William Page (1868-1967) developed a combination rolling contact and trunnion bascule bridge.

The overhead counterweight (or the approach roadway acting as the counterweight for

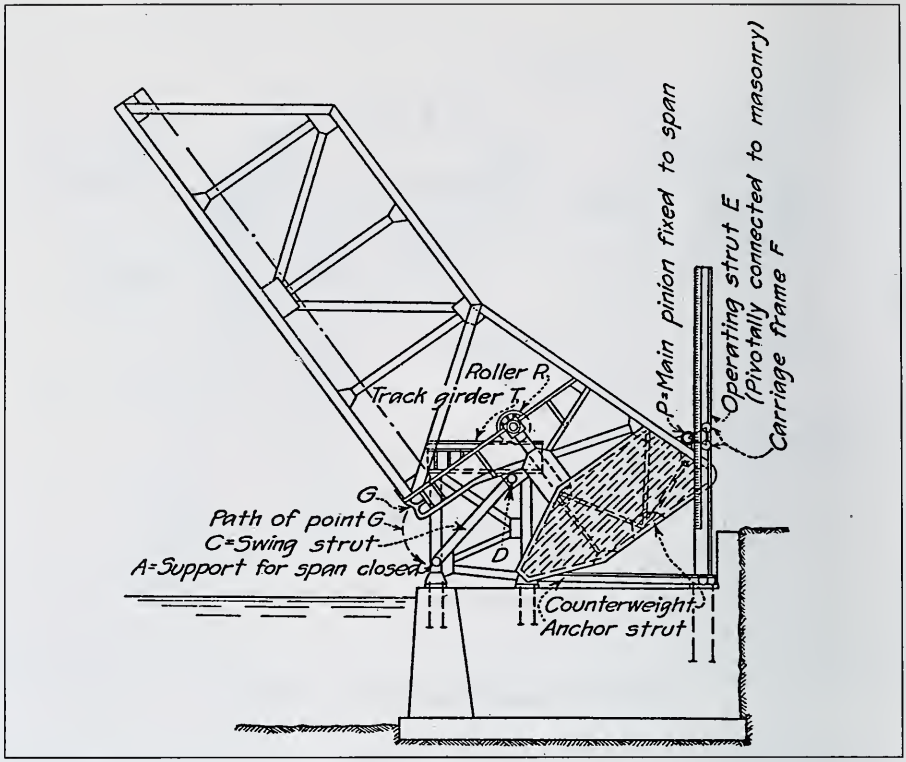


FIGURE 5 – Rall Type Bascule Bridge

highway bridges), supported on rear trunnions, rotates downward against a curved rack on the bascule leaf. The bascule leaf, supported on separate trunnions, is pulled open as the counterweight and pinion operate against the curved rack. Only four of the Page Type bascule bridges were constructed between 1902 and 1907.

In 1921, Dr. Hugo Abt, chief engineer of the American Bridge Company, attempted to improve upon the Page Type bascule with the bridge shown in Figure 6. It became known as the ABT Type (sometimes referred to as the American Bridge Type) bascule bridge. Like the Page Type bascule, the counterweight operates on a separate trunnion and rotates forward to push the movable leaf open. There were only eight of the ABT Type bascules built of which three remain in service today.

Another very notable innovator of bascule bridges was Joseph Baerman Strauss (1870 - 1938). Although Strauss has been given credit for the design of the Golden Gate Bridge in San Francisco, he may be best known by railroaders for his numerous types of bascule bridges. The Strauss types include the overhead counterweight bascule, the heel trunnion bascule, and the direct lift bascule. In 1904, Strauss designed his first bascule bridge, a single leaf, single track, overhead counterweight type for the Wheeling and Lake Erie Railroad across the Cuyahoga river in Cleveland, Ohio. See Figure 7.

The rear of the overhead counterweight bascule leaf is supported on fixed trunnions. As illustrated in Figure 8, the overhead counterweight, suspended from separate trunnions, moves vertically as the bascule leaf is opened and closed. For shorter through-girder spans, the machinery is located adjacent to the structure and operates against a convex rack on the leaf. For longer through-truss spans, the bascule leaf and operating machinery are located above the track level on a fixed supporting tower. The bascule leaf is opened and closed using a hinged operating strut.

The differences between the overhead counterweight type and the heel trunnion type are the location of the bascule leaf trunnions and the movement of the counterweight during

FIGURE 6 – ABT Type Bascule Bridge

FIGURE 7 – Strauss's First Bascule Bridge

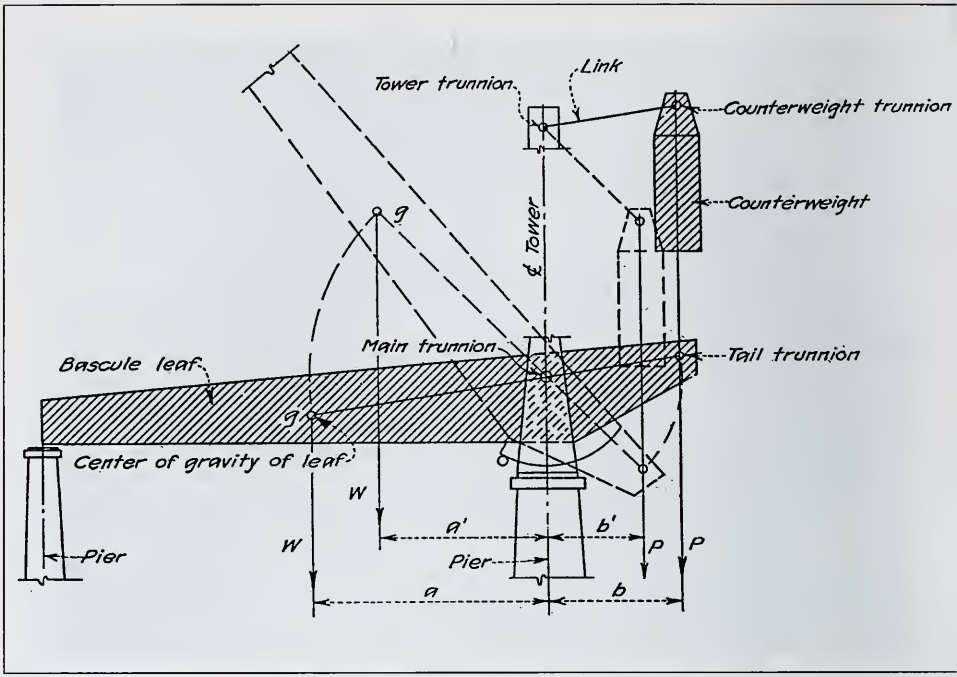


FIGURE 8 – Overhead Counterweight Type Bascule Bridge

operation of the span. For the heel trunnion type, the bascule leaf trunnions are located at or slightly below the track level. The operating machinery is located on the fixed support frame and pulls against the hinged operating strut which raises the bascule leaf as the counterweight, rotating about a separate trunnion, lowers.

One of the most famous bascule bridge designed by Strauss is the double-leaf, heel-trunnion span across the St. Mary's channel at Sault Ste. Marie, Michigan. The unique feature of this two-track structure, shown in Figure 9, is the moment transfer at the center of the span, in addition to shear transfer which is needed to insure the deflection at the cantilevered end of each leaf is the same. The rotation of the counterweight, between the opened and closed position, can clearly be seen.

Another movable span, which is a combination vertical-lift and bascule, was designed by the Strobel Steel Company in 1913 for the Chicago, Burlington and Quincy Railroad. The design converted a 148 foot pin-connected through-truss span to a lift span with 32 feet of vertical clearance, utilizing a "Rall" type bascule counterweighted arm on the top of the lift towers.

In 1918, Joseph Strauss utilized a similar concept to design a 210 foot span with a 40 foot lift. See figure 10. Only three of these "direct lift" type bascule bridges have been constructed.

Numerous other types of bascule bridges have been designed, some successful and others never constructed. For instance, Thomas Brown designed and patented a bascule span which was opened using a vertical counterweight hung from cables which passed over sheaves on top of a tower and attached to the bascule leaf. An example of the Brown Type bascule is the span constructed for the New York Central Railroad in 1914 at Sandusky, Ohio.

There are presently 119 single-leaf bascule bridges in the United States that carry railroad traffic. These range in size for a single-leaf bascule span over navigation channels from

FIGURE 9 – Double-Leaf Heel Trunnion Bascule Bridge

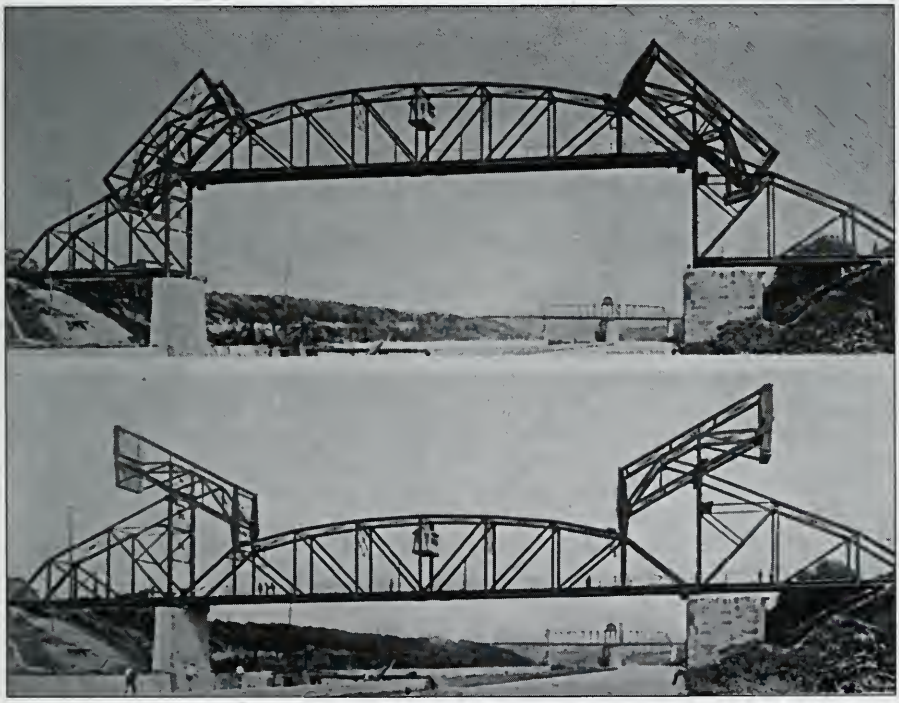


FIGURE 10 – Direct-Lift Bascule Bridge

25 to over 200 feet. Bascule spans are also the widest, accommodating up to three tracks on a single span.

Combined Railway/Highway Spans

With more than 8,000 miles of navigable waterways in the United States, there are thousands of bridges, both fixed and movable, needed to convey both railway and highway traffic across these waterways. In many instances, the movable bridges have been designed to accommodate both railway and highway traffic.

The Santa Fe Railroad's combined used swing-span bridge constructed in 1924 across the Mississippi River at Fort Madison, Iowa, is one of the longest and heaviest swing-spans ever built. This structure provides a 200 foot navigation channel on each side of the pivot pier and carriers two lanes for vehicular traffic on the upper level and two tracks for rail traffic on the lower level.

One of the most famous and unusual combined-use movable bridges is the vertical-lift "steel bridge" across the Willamette River at Portland, Oregon. Constructed in 1912 for the Oregon and Washington Railroad, the lower level is designed for two tracks of rail traffic and the upper level for highway use providing a 205 foot navigation channel. The unusual feature is the independent movement of each level. The lower railway level is suspended at each panel of the through-truss upper highway level. The lower level can be raised by telescoping the suspenders inside the upper level trusses. When higher lifts are needed, the upper and lower levels are raised.

Another combined highway and railway vertical-lift bridge is located over Portage Lake near Houghton, Michigan. The bridge, constructed in 1959, is designed to carry four lanes for vehicular traffic and two tracks for rail traffic. The lift span is normally kept in the intermediate support position which allows the vehicular traffic to use the lower level and most waterway traffic to pass under the structure. When needed for rail traffic, the lift span is lowered and vehicular traffic uses the upper level. For larger ships, the span is fully lifted and closed to all vehicular and rail traffic.

Bascule bridges have also been designed to accommodate both highway and railway traffic. The double-leaf, double-deck bascule across the Chicago River provides three lanes for vehicular traffic on the lower level and two tracks for light-rail commuter trains on the upper level.

Another example is the single-leaf bascule bridge constructed in 1920 near Wingo, California, in which the single track and single roadway lane use the same deck.

Bridge Operations

The earliest movable bridges were moved either by true "horse power" or with manual cranks. During the past 100 years, many improvements have been made in the operation of most of our movable bridges. Electric bridge operations have progressed from the simple drum controller to sophisticated systems with programmable logic controllers (PLC) for semi-automatic control of the movable span. Relatively recent innovations have led to the use of hydraulic cylinders and low speed high torque (LSHT) hydraulic motors to operate all three types of movable bridges, hydraulic disc brakes on the operating machinery, and remote control operations. The comfort of the bridge operators has also improved. The once wooden shanty has been replaced with climate controlled facilities with all the comforts of home.

Conclusion

There are presently more than 600 movable railroad bridges in the United States. As shown in Figure 11, 540 of these are operable. Included in the 540 movable bridges are several which have a combined use for both railway and highway; nine swing-span bridges; nine vertical-lift spans; and eight bascule spans. The average age of the movable spans is almost 70 years old, with the oldest movable bridge on the American railway system being more than 120 years old.

Type of Span	Number of Examples	Channel Widths, feet	Average Channel Width, feet	Average Age, years
Swing Spans	310	20 - 236	86.8	77.6
Vertical-Lift Spans	108	33 - 500	226.2	48.3
Bascule Spans:				
Single Leaf	119	25 - 225	89.1	68.4
Double Leaf	3	195 - 282	225.7	84.0
All Moveable Spans	540	20 - 500	115.2	69.5

FIGURE 11 – Tabulation of Moveable Railroad Bridges in the United States

With the ever-increasing expense of maintaining their movable bridges, many owners have sought permission from the US Coast Guard to restrict the frequency of bridge openings. Some have also eliminated non-cost-effective structures. There will always be a need for movable spans over navigable waterways. In the future, the number of movable spans will likely decrease as rail lines are consolidated or as more than one railroad combines the expense of maintaining a structure. New and improved technologies must also be developed to provide more efficient and reliable operation of these structures. As always, reliability, safety, and maintainability are the key factors in the operation of any movable bridge. As shown here, the types of movable railroad bridges are limited only by technology and the ingenuity of the design engineers. However, we must all understand that, "it's a machine, not just a bridge." It must be designed with thought, constructed with precision, and maintained with care.

Lastly, I would like to thank each of the railroads who responded to my requests for information regarding the movable bridges on their system and helped to make this presentation possible. Thank you. (Applause)

Mr. Lileikis: Thank you, again, Rick.

Our final presentation for this afternoon is a feature entitled Counterweight Trunnion Repair, Amtrak Thames River Bridge in Groton, Connecticut presented by David Barrett of Modjeski & Masters. David has been with Modjeski & Masters for three years in their Harrisburg, Pennsylvania, office. He graduated with a Bachelor of Science degree in mechanical engineering from Messiah College in 1981 and received a Master's in mechanical engineering from the University of Washington.

Dave's principle activities at Modjeski & Masters is to deal with mechanical engineers, but he also delves into the structural aspects of engineering.

Please welcome David Barrett. (Applause)

COUNTERWEIGHT TRUNNION REPAIR AMTRAK THAMES RIVER BRIDGE

David Barrett
Modjeski & Masters

Thank you for the introduction, Joe. I would like to discuss with you one of the major movable bridge projects that we have been working on lately. It's a project working on a bridge along one of Amtrak's busiest lines between New York City and Boston. The project is the emergency repair of the Groton bridge which spans the Thames River in Groton, Connecticut.

The Groton bridge is double track open deck span bridge which consists of a bascule span in the center and flanked by thru-trusses. The bascule span is the type known as the Strauss or heel trunnion bascule. The Strauss type bascule bridge operates on the principle of a folding parallelogram formed by these four trunnions at points A, B, C, and D. The pin-connected parallelogram is formed by the edge points of the truss for the movable span as well as the counterweight truss in an operating link which extends between points C and D. The Strauss bascule bridge has two fixed trunnions. The leaf rotates about B and the counterweight rotates about trunnion A. Trunnion C and D both move as the bridge opens.

I have a sequence of slides showing the opening of what a Strauss bascule looks like. The force to open the bascule is applied to that operating leg which is connected to trunnion D.

Here is the span fully closed and you can watch that parallelogram formed by the four trunnions. As the bridge opens, that parallelogram flattens and at full opening the parallelogram is almost completely flat. Then it opens up again and the parallelogram expands.

The advantage of the Strauss bascule included unlimited vertical clearance through most of the channel way. It also includes having the counterweight located on top of the rail. With the counterweights above the rail, it eliminates the need for counterweight pit under the tracks. This allows you to put the tracks down closer to the water eliminating the need for a long approach at a grade.

Over 400 Strauss bascule bridges were constructed in the early 1900s, many of which are still in operation today. The Groton bridge was completed in 1919 and with the span of 188 feet of movable leaf, that's the longest of its kind at that time. As many of these bridges reach their golden years, the wear and tear of tens of thousands of openings start to take a toll. This wear is perhaps most evident in trunnions or bearings. The counterweight trunnion is a large bearing responsible for the movement allowing the rotation of the three million pound counterweight. Now I have been trying to think of a suitable comparison for a three million pound counterweight. I talked to somebody who said it is equivalent to the weight of seven fully loaded locomotives rotating on those two bearings.

In the case of the Groton bridge, these bearings are 45 inches in diameter and have a length of 40 inches. As the years progressed, the movement of the leaf and the counterweight caused wear inside that bearing. Corrosion can also contribute to that wear.

A slight note for those of you who aren't sure what a trunnion is. It is really just a journal bearing. It is similar to the bearings used in the early days for railroad cars with the famous hot boxes at the side. Eight steel cores rotating inside of a bronze sleeve are quite a bit different than the roll around bearings used today.

At this time, I would like to take a few minutes to explain how the trunnion bearings work. Here is a front view with a Groton counterweight bearing. Basically all you can see is the bearing cap held down by those two bolts. Although if we look at an isometric view, you can see the major components. You have a pin extending through the gusset plates on both

sides. The pin is held in place by two lomas nuts, one on each side. The pin is surrounded by a pin or bearing sleeve that is located between those gusset plates. The entire bearing assembly is held together by the retainer rods or the retainer bolts. These retainer bolts act to keep the wear sleeve rotating along with the gusset plates.

If we look at a cross-sectional view of the bearing, you get a better view of that 20-inch diameter pin for the Groton bridge. The pin is surrounded by this wear sleeve and together they form a 35 1/2 inch diameter that rotates inside the bronze bushing located at the top and bottom of the figure.

If we look at the loads applied to the bearing, we see that three million pounds counterweight bearing down through those gusset plates. That force is countered by an uplift force due to the bronze bushing represented by those arrows along the bottom. We follow the load path, go down to the gusset plates and it is transferred through that 20-inch diameter pin. Also the two and one quarter inch retainer bolts transfer some of the load. These retainer bolts also see additional loading due to the frictional force on that wear sleeve surrounding the pin.

This photo shows the results of years of wear on the bearing. The white gaps underneath the retainer bolts are gaps that open up due to wear. Also a gap opens up under the main diameter. As these gusset plates wear, the plates start transferring dead load sheer to the retainer bolts. With the movement of the bearing, there is now sheer and bending on these retainer bolts. Due to uneven wear of the two trunnions, one on each side, this can cause the alignment of the bearings to get off which can cause problems with the seating moving into the bridge. It also can cause bearing stresses into the different legs of the parallelogram.

The first sign of trouble for the Groton bridge was a loud snapping noise heard during opening and closing. The snapping noise was caused by the gusset plates rotating on that core pin. Due to the wear of the pin on the gusset plates, the opening of the gusset plates is now bigger than the pin. As the bridge opens those 80 degrees, the length of the two arc is the surface of the pin and the surface of the gusset plate hole are different in length. This difference in length is going to require some slippage during opening.

This occurs in many very small increments. We call the phenomena stick slick. It takes a good deal of force to cause two steel surfaces to slip over each other especially under very high unit pressure. But as this bridge opens, these surfaces deform, building up energy until the amount much energy needed is reached. Then the two steel surfaces jump or slip over each other releasing the energy and this release of energy can be heard as a loud snapping noise.

Now, perhaps this snapping noise is to be ignored, but when the ends of the retainer bolts started breaking up and 15-pound nuts were falling 60 feet under the track, that attracted attention.

Here is one of the ends of the original retainer bolts that failed. You can see it is originally two and a quarter inches in diameter. But due to wear, the diameter is now only a little bit over an inch.

If we look at a cross-section of the wear, the wear is symmetrical about the shaft. Most of the wear is occurring in that 80 degrees through which the bearing side of the bolt is rotated during opening. Enough wear and tear and these bolts are going to fail as we have seen.

Once these bolts fail, it is going to allow the gusset plates to spread which would compound the wearing problem inside the counterweight trunnion bearing. We can see for ourselves what this wear looks like. I also have some pictures of other bridges we have worked on.

This is a picture of the Seabrook bridge down in New Orleans. Not much wear can be seen until that lomas nut is removed from the pin or the retainer bolt nuts are removed. One thing you can see here is the lubrication pipe extending through on the left of the bearing at the bottom of the bearing.

Once that lomas nut is removed, you can see that crescent-shaped wear gap start to open

up underneath the pin. Also you can see the retainer bolt holes are no longer circular, but more oblong now. The gap here is approximately three quarters of an inch under that pin.

Here you get a closeup view of one of those retainer bolt holes. You can see that the gap is worn just in the gusset plates and not in the wear sleeve. That bolt failed right at the interface between the wear sleeve and the gusset plates. In addition, this wear can cause the lubrication types to sheer off leaving the bearing dry. With that bearing dry, the worst case scenario can develop. The load on the pin can become more and more localized on top of the pin. It becomes almost a pointed loading.

Once that pin is point loaded rather than having a distributed load over the top, the pin can crack as can be seen here in the face of the pin on the lower left side extending through the whole radius.

Here is another bridge looking at the Seabrook down in New Orleans. Again, the wear gap over the pin can be seen pretty clearly.

This is the St. Claude bridge. During rehabilitation those pins were removed and the wear spots for the gusset plates bored down on the pin can be seen at either side. Rather than completely replacing the counterweight bearings, which would require quite a bit of false work these bearings are rehabilitated. This sometimes includes redrilling those retainer bolt holes or moving that oblong at the bottom using a larger diameter. Then reboring the hole for the pin. Then larger retainer bolts are inserted and a larger diameter pin is cooled and jacked into place. Unfortunately with the Groton bridge, there was a clearance problem on the outboard side with bearings.

If you look again at a cross-sectional view above the C in counterweight, you can see there is an approach truss just a few scant inches on the outboard side. This necessitated drilling to be done all from the inboard side which effectively doubled the length of the drill bits that would be required.

Here is a field shot of that lack of clearing with the bearing on the right and the truss work on the left.

In 1991, an engineering firm was hired to address the wear problems with the trunnion bearing. The solution proposed and implemented required that those retainer bolt holes be redrilled out from two and a quarter inches to three inches.

Here is a slide of their design and the new three inch retainer bolts. These retainer bolts were increased in size and also a higher strength steel was used. It's a 4330 alloy steel and 190 ksi strength. It is approximately 45 times stronger than the original bolts used. These retainer bolts were given a very high free load of 7,500 foot pound. In addition, a specially shaped mating shim was inserted into that wear crescent gap underneath the pin.

Unfortunately, within a week of completion of that new design, the ends of those rods started to fail again. These rods failed five days after completion. So again you have a 20 pound nut falling on the tracks attracting some attention.

Looking at the fracture surface, you can see it has failed due to bending fatigue, not due to tension.

Modjeski & Masters was contacted in 1994, three years after the installation of the original bolts. Now 16 new bolts were installed, eight per counterweight trunnion bearing.

Here is a picture of one of the counterweight trunnion bearings. Out of the eight installed on each bearing, only three bolts were still intact. It had been three years and five out of eight had broken. So we examined the bolts ultrasonically and found no sign of sheer failure between wear sleeve and the gusset plate, the typical failure spot. We did an ultrasonic examination of the pin and found no discontinuity or no cracks so we came up with our own design.

We decided there were three problems with the first rehabilitation. First of all, the nuts at the end of the new three-inch retainer bolts didn't seat squarely. The gusset plates were no longer perpendicular to the bolt holes and this caused localized loading at one corner of the

nuts. In addition, the gusset plates flexed out slightly during operation of the bridge which put a serious load on the bolt holes and the high preload applied to the bolt to worsen the problem.

In our design, we had addressed all three of these problems. Because there was no sign of sheer failure between the gusset plate and wear sleeve, the existing three-inch retainer bolts were remained in place. New two-inch diameter holes were drilled between the retainer bolt holes and a one and 7/8 inch retainer bolt was to be inserted. The bolt is under size so it doesn't assume any sheer load, just tension.

In addition, fabric pads with steel backing plates were to be attached under the bolts to provide favorable load distribution. These plates also functioned as keeper plates for those three-inch retainer bolts. Those bolts were to be cut off flush with the outer edge of those gusset plates.

Now a quick walk through the actual implementation of our design. We came up with some interesting problems. Because access was limited to the inboard side of the trunnion bearing, we required a highly specialized drilling process with a horizontal bore of nearly four feet through solid steel. By January of 1995, the contractor, Fornier Steel of Baton, Maine, had acquired the necessary custom drilling head and wear bars and cutters that were needed and was ready to begin drilling. This custom drilling rig was constructed and brought into place to be used for drilling those new two inch diameter holes. Alignment was accomplished by using a thirty thousandths of an inch diameter piano wire. That was centered at the outboard edge of the bearing. This was then fed through an alignment insert at the inside portion of the drill jig and fed through the drill jig. The alignment insert is metal and has a fifty thousandths of an inch hole and that allowed for a ten thousandths of an inch misalignment before that piano wire contacts a metal insert. By checking for electrical contact between the piano wire and the inserts, you can see how your alignment is doing.

The drill jig was attached to the gusset plates using a threaded rod for welds which were welded on. This way any adjustment of the alignment of the drill jig could be accomplished by just bolting closer one of the drill jigs in the corners until there is no longer electrical contact between that piano wire and the insert.

Here is a shot of that custom drill head used. You can see those original spots are replacement cutters and also replaceable wear bars in case of breakage. The first hole drilled required approximately nine and a half hours for completion. This was much longer than anticipated, due to frequent breaking of the cutters and replaceable wear bars. The second hole took almost as long. The following day, again the progress was very slow with many broken bits. After breaking one of the drill bit holders for which the contractor had no replacement, it was decided to stop for the weekend and start again the next week. One of the main problems that was causing all the breaking of those replaceable cutters and wear bars was the overhang of the boring shaft which you can see in this case extended out perhaps three feet past the back of the drill jig. When starting the bore, it's about four or five feet back which is enough shaft length to develop quite a bit of vibration during drilling. So we discussed with the contractors what we should do and we suggested that they support the end of that drill bar, that they get some new wear bars that wouldn't keep jamming up, and also that they strengthen the interface between the custom drill head and the boring bar. In addition, the contractor was given permission for using a twist drill to bore through the last three inches of that final gusset plate thickness at the end of the four-foot hole.

After making those changes, progress went more rapidly. This is the slide of the south counterweight trunnion with all eight bored holes completed. The three-inch bolts were then cut flush with the outer gusset plate edge and any surface inconsistencies were ground flushed so the washer plate with the Fabrico pads would seat up flat against the gusset plates. The Fabrico pads were glued to these washer cut plates and then passages for those lubrications were trimmed.

The whole assembly was painted by Amtrak personnel. Anti-seize compound was applied to the entire length of the bolts and also to the spherical washers. The spherical surface was coated with the anti-seize compound so that nothing would seize up and assume any bending. The outboard nuts were installed with two threads sticking through and the bolts were tightened and the ends bored side. The drilling jig was detached and aligned for drilling at the north counterweight.

After completion of drilling and installation of all the new retainer bolts, four of the bolts were removed and strain gauge bolts were inserted. These strain gauge bolts are capable of measuring bending at both ends and also capable of measuring tension to find out what was happening as the bridge opened to make sure they weren't accepting any bending loads. The strain gauge wire is fed out through these threaded couplings at both ends of the bolts. Unfortunately, you have seen the clearance problem at the outboard side so that required us to remove the threaded couplings at the outboard side. This greatly increased the chance of damage to the strain gauge during installation and during removal. Therefore we installed the south counterweight and everything went fine with the exception of one gauge that didn't work. But when we went to the north trunnion during removal and installation, three out of four bolts were damaged so they required some field repair to get them operational again.

Data was recorded for a complete opening and closing three times; three complete cycles for both the north and south counterweight trunnion. After all testing was completed, the strain gauge bolts were removed and the permanent bolts were re-installed. The peak bending stresses were measured and ranged from between three ksi and 17 ksi. The minimum yield strength of the bolts is 105 ksi so there is quite a margin of safety, 17 to 105. The life expectancy of the repair far exceed the life expectancy of the bridge. I think it's good for 500,000 openings according to those numbers.

Similar repairs to this would have been performed on just a couple different bridges, one of which has been in place for 22 years now. We repaired it and there has been no breakage of retainer bolts yet.

For the Groton bridge, we completed rehab eight months ago and there has been no breakage and we anticipate similar results in terms of many years of good service out of that rehabilitation. With this rehabilitation, the Groton bridge should, with regular maintenance and lubrication, be sound and operational for years to come.

I would like to thank Joe Lileikis and Amtrak for the opportunity to work on this project and give this talk today.

Mr. Lileikis: Thank you, David. That was an excellent job.

That concludes our afternoon session. I do want to remind you to please fill out the orange survey cards and turn them into us if you would please.

The yellow cards for topics for next year's conference should be in the back. Please pick one up, fill it out, and drop it off at the registration desk please. Don't forget to attend the traditional REMSA reception between 6:15 and 7:15 this evening.

If there is no additional business, this session is adjourned until tomorrow morning at 8:30.

(Adjourned)

JOINT SESSION

Wednesday, September 27, 1995

President Nordlund: Good morning. I trust everyone enjoyed themselves last night at the reception. I'd like to remind everyone to complete their blue survey card and turn it in at the close of today's session. At this time I'll turn the podium over to Pete Murgas, our program chairman.

Mr. Murgas: Our next feature is "Roll In Track for I-93 Widening" and will be presented by Bob Simon, area construction engineer with Amtrak. Bob is a native New Yorker and holds a Bachelor of Science degree in civil engineering from Northeastern University in Boston. He has progressively worked through various engineering positions beginning with steel mill railroads in Pittsburgh and Cleveland as well as the Boston & Maine. Bob is presently completing his seventh year with Amtrak and is involved with overseeing with direct responsibility all track, signal, bridge and building type construction on the MBTA Commuter Rail System in the Metropolitan Boston area.

ROLL IN TRACK FOR I-93 WIDENING

Bob Simon

Area Construction Engineer
Amtrak

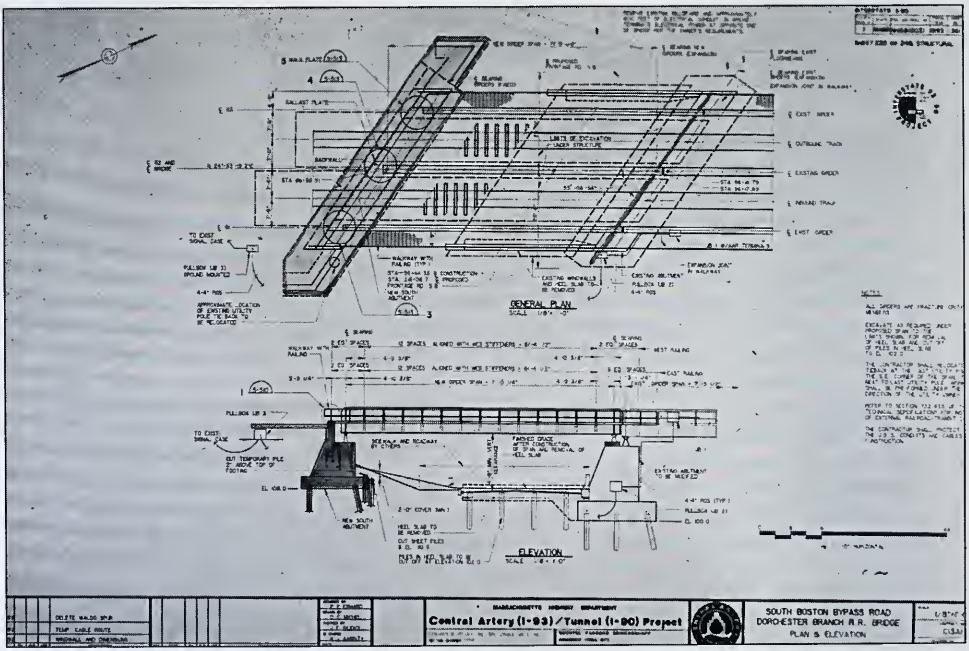
Ladies and gentlemen, let me thank you for allowing me to make this presentation this morning and to share with you Amtrak's experience with the construction of this double track roll-in bridge structure.

As you are well aware, a major series of projects called central artery third harbor tunnel construction is taking place over the course of the next decade in the Boston area. No doubt massive highway work has required major railroad reconstruction projects in many of your areas. The Boston experience is unique in that the coincidence of work efforts in and around south station near the Fort Point Channel and north station through the major north terminal areas by the Charles River all have tremendous effect on MBTA commuter and Amtrak intercity operations.

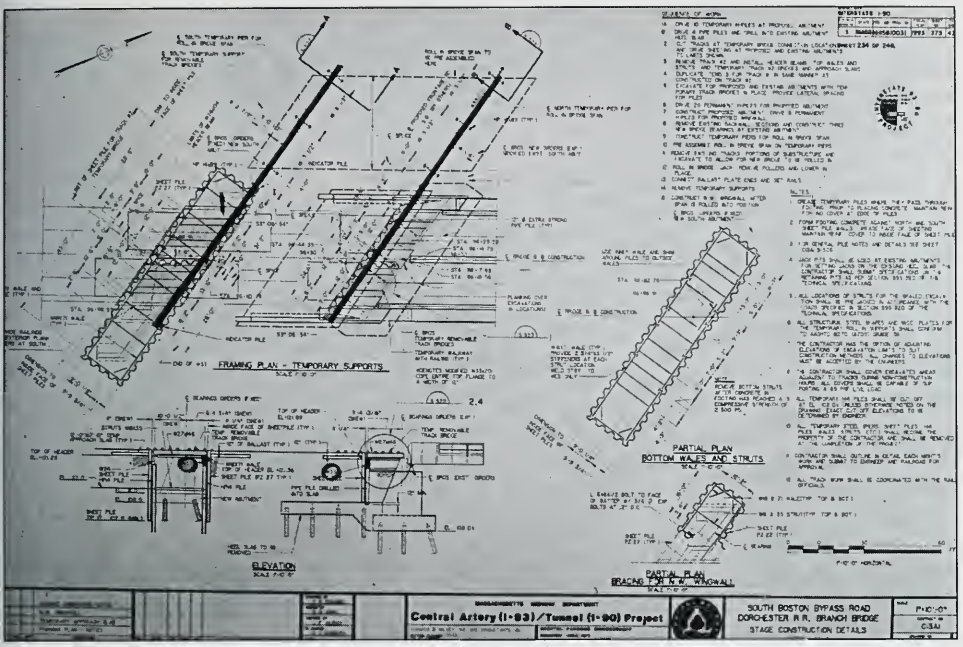
Specifically today, I would like to talk about the construction of what is called the by-pass road to the third harbor tunnel and the need to widen existing I-93 interchange with the additional span on the Dorchester Branch Commuter Railroad. MBTA's Dorchester Branch carries half hour headway trains on a 10-mile segment between Boston south station and the suburb area called Readville/Hyde Park, south of Boston. The double track branch line was rehabilitated as a temporary route for south side and Amtrak trains while the whole southwest corridor reconstruction project took place in the 1980s. This route was not built for a longer life than approximately 15 to 20 years. The signal system is in need of rehabilitation combined with the fact that there is no mid-branch interlocking. This precludes the construction, on a one track, one bridge basis, and requires all work to be done on weekends.

The present structure consists of three spans, plate girder, ballast deck structure. It was

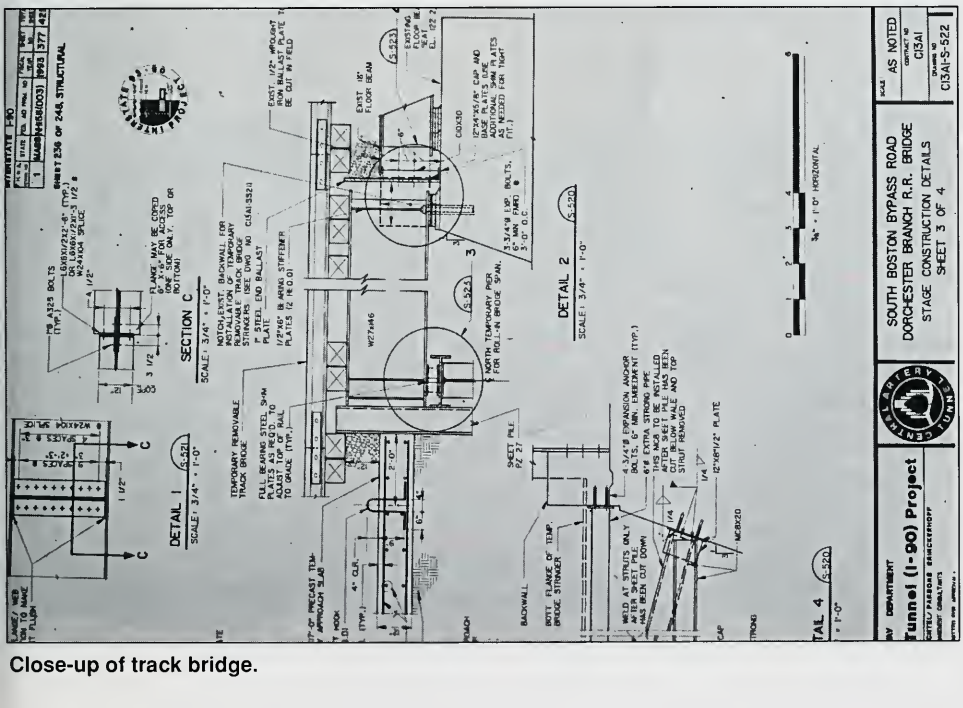
View of track area prior to bridge construction.



New abutment to be built, new pier that was the old abutment and new double track span to roll in.

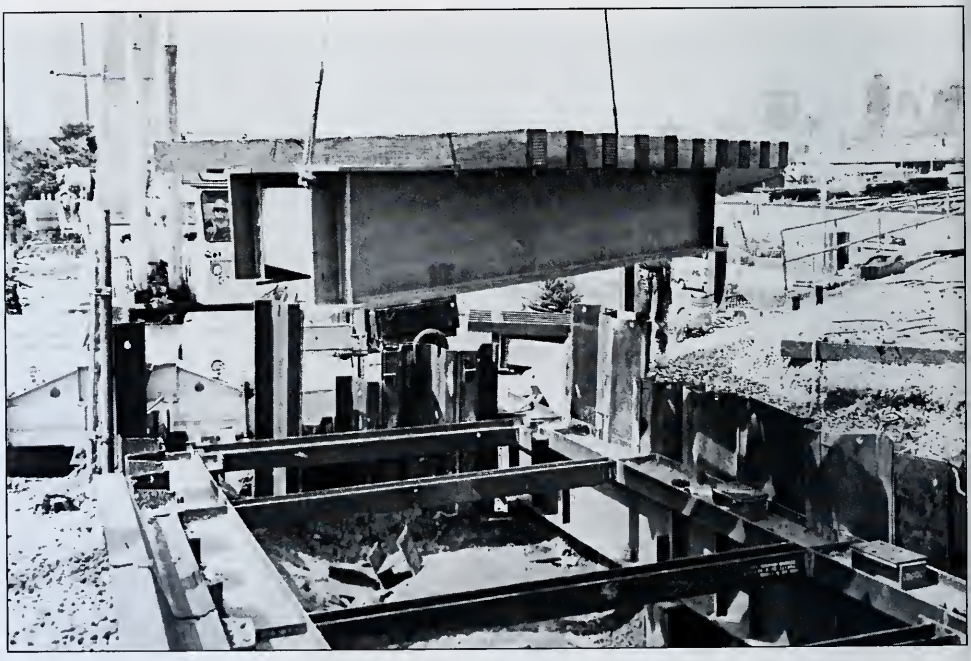


Location of 4 temporary track bridges that were removed on weekends allowing the modifications to prepare bridge seats for new structure.



Close-up of track bridge.

Steel piles for temporary supports to build new bridge prior to roll in.



Placing one of the four temporary bridges.

Steel beams and rails in place to support erection of new bridge.

New bridge erected along side of active tracks.

built in the early 1950s with the construction of the southeast expressway and now requires an additional 80-foot span to be located basically on the west end, allowing additional frontage roads for southbound traffic. As you can see, billboards, railroad signals, side tracks, and other utilities must be removed or relocated to make way for a construction area to build a structure adjacent to the present railroad alignment which would then be rolled in.

The existing east abutment would be converted into a pier and a new west abutment would be built for receiving the roll-in bridge structure. All of this work had to take place with weekend outages. We have our structure to be assembled at one side on temporary steel girders. These girders would then allow it to be rolled into place. A layout of four temporary track bridges. Initially, sheeting and steel piles are installed on weekends with ballasted track returned back for train operations Monday morning at four locations, one temporary bridge per track in the area where the new abutment will be built and one temporary bridge per track where the modified pier will be made from the existing abutment.

After sufficient piles and sheeting were installed, the point of no return was reached for installing the first set of track bridges. As you can see the four temporary locations, two smaller 12-foot track bridges immediately tied into the existing abutment and two longer 20-foot track bridges to provide an area for construction of the new west abutment, all while trains are running in service on a Monday through Friday schedule. Again, we are fortunate that the weekend does not have commuter operation.

Track had been removed to allow the sheeting and piling to be installed and then replaced as ballasted track. This occurred on several weekends at each of the four locations prior to establishing a girder placement which would then allow for the bridge seats of the temporary bridges. Pile driving during the week took place to create a temporary structure of two horizontal girders that would provide for the bridge structure to roll from the north side of right of way and onto the final alignment on the final two day cutover weekend.

The point of no return was set, modifications were made for access, protection of ballast, and the first temporary bridge structure was installed. Sheeting along the centerline of the six foot, the placement of the girders that will ultimately support the temporary bridges as well as allow for the modification to roll-in the new structure once this new abutment has been established.

These piles, girders, and whalers were all previously installed with ballast and track returning. Sheeting to act as ballast retainer, whalers for opening up this portion of the excavation and to allow for placement of bridge seats for the temporary bridge. Temporary bridge construction was repeated at the four locations. Prepared track panels were removed and replaced on many weekends. Ties were pre-dapped and mounted to the structure. You will note the close relationship of center of rails to approximately the center of temporary bridge beams which were required when we put Pandrol plates on top of the bridge timbers.

A bolting arrangement for ties through the top outside flanges on the temporary bridge provided for a non-conducting grout material for countersunk top of bolt with nuts of the bolt arrangement on the bottom to hold the timbers in place on the bridge and this non-conductive grout prevented any shunting for signal system. Again, one track, one side, one bridge per weekend was completed and field modifications took place to assure ballast retention at the temporary bridge placement. This process was repeated for four weekends until all four temporary bridges were installed.

Now work can commence. For the next series of weekends, temporary bridges were easily removed on Friday night for placement back early Monday morning prior to the first train. Saturday and Sunday continuous operation by the contractor provided for installation of the permanent piles and concrete caps to receive the final roll-in bridge structure. These structures were used temporarily and for approximately two months prior to the actual roll-in of the bridge structure in the fall of 1994.

Precast concrete approach slabs installed during the weekend outage for bridge roll in.

Modified old abutment now ready to receive the roll in of new bridge.

Simultaneously as work took place to prepare the new abutment and modify the existing abutment to convert it to a pier, the double track plate girder bridge structure was built along side the railroad on top of the temporary supports. The new structure, a welded reinforced steel plate girder, common center girder to outside girders with waterproofing material to prepare for ballast deck was designed on the basis of expediting all work as much as possible outside of the envelope for time to jack the bridge over and place the new structure on alignment. Ballasting and track work was to follow over a two day weekend outage.

Jointed rail, which was cut in earlier, prepared with Pandrol plates and clips quickened track construction on new structure upon the completion of the pier and abutment work. The actual day of roll-in had been well discussed and had many preliminary steps reviewed with some interesting shortcuts taken. One shortcut was the use of excavatable concrete behind the new abutment. The excavatable concrete was easy to place ahead of time while the temporary bridges were there, self-leveling and would fill voids. This saved many hours that were otherwise scheduled for placing structural back fill, layering, and compacting to bring a gravel back fill up to grade.

Additionally, assisting us was the concept that the approach slabs from the ballasted track onto the new structure clearly need to act as a stiffener for the track modulus transition onto the new bridge. By prefabricating these approach slabs and establishing a keyway system between the slabs, this allowed us to reduce time in the placement of the slabs instead of pour and set in place. We acknowledge that the keyway may move over time but in essence, this area would still be a strong support as a transition between the track modulus on and off the bridge structure.

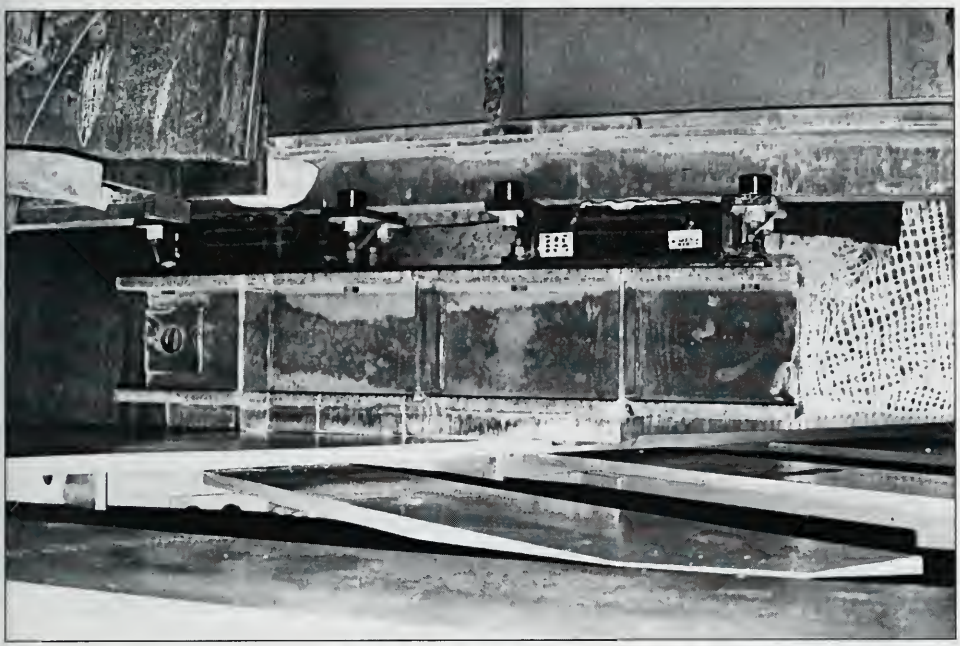
The rollers themselves form the staging area for the support of bridge erection and these common girders extending and becoming part of the supports for the temporary bridges. The new bridge extends beyond on either side of the girder and allows the permanent bridge seats, both fixed and movable, to be placed on new abutment and converted abutment to pier independent of the temporary structures presently supported at the four locations.

Welding, waterproofing, painting, touch-up, or everything that could be done ahead of time was carefully looked at, reviewed, and done. Schedules for the two day outage were reviewed and contingencies established for round-the-clock monitoring to assure that the worse case bussing of commuter trains for the Monday morning option was available and a secondary case of establishing the inbound track first for commuter trains could take precedent. Ultimately, we had both tracks in service for both inbound and outbound commuter trains the beginning of Monday morning.

As you may well expect, we required, prior to cut in weekend, that the bridge structure on the rollers be jacked back and forth several feet to assure the roll ability of the equipment and to test the hydraulics, the cables, and jacks to assure sufficient strength to move the structure. Our flurry of activity on cutover weekend to finalize the removal of steel ballast plates off the old structure, prepare for the roll in of the new structure, place the final permanent bridge seats, fixed and movable for the new structure and then ultimately prepare to cut off any obstructions and temporary steel which would prevent the new structure from being rolled into place. The placement of the jacks that will lift the bridge to remove rollers and lower this bridge down to be placed onto the new bridge seats.

The final modifications to the track that will roll the new bridge in, jacks to lower it, and placement of the bridge seats. Excavating the track and material to bring down the ballasted area between the two temporary bridge cofferdams to then lower and clear a space for bridge roll in.

The roll in of the bridge was done by hand, steel cables and roller assemblies brought along the top of a six inch by six inch steel billet in a process to roll the bridge in and assure the structure remains parallel and rollers do not bind. The roller detail and the steel support presently holding the bridge, the extended six by six steel billets that acted as rails to carry the bridge across and the new structure was rolled into place Saturday night into early Sunday



One set of new roller assemblies.

Overview of new bridge in place and new approach slabs ready for ballasting and track placement.

morning. Hydraulics set up with a control station for the lifting, lowering, and some movement both in two directions horizontally to get the final adjustment and place the structure.

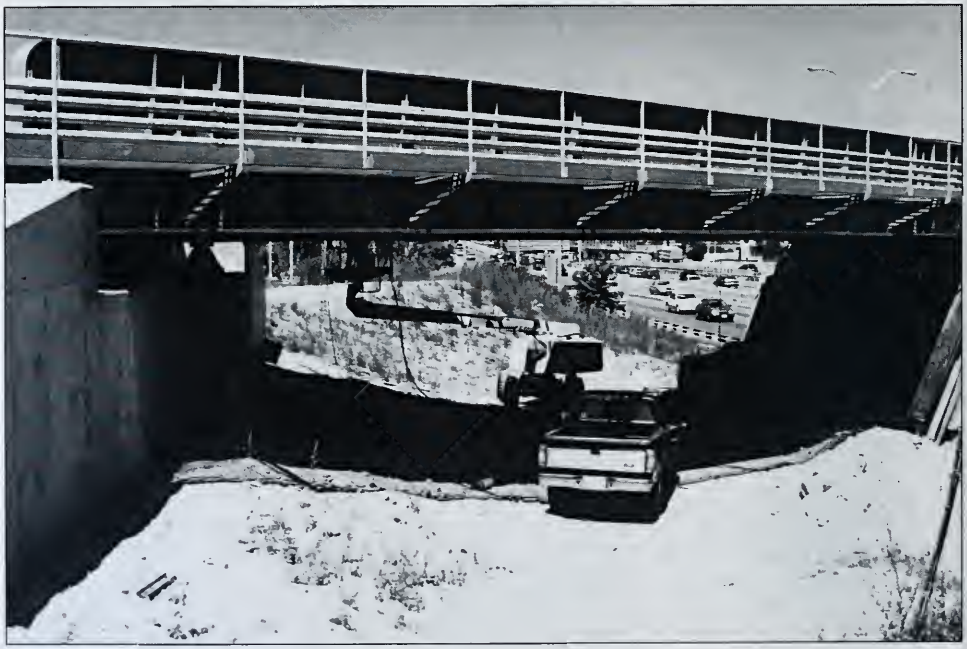
We achieved the bridge roll in early Sunday morning and we are now preparing the final plates to be welded that take us off each end of the bridge tying us to the existing bridge structure and over the top of the new abutment to the approach slabs. Temporary ballast retaining system off of the approach slabs would later be replaced with the full concrete wing walls. Even with four welding crews, a good amount of time was expended prior to the waterproofing which took place in these last areas of the bridge. Completion of the major track work effort on the new bridge continued through Sunday night.

Conventional surfacing equipment, ballast regulator, tamper, compactor, several ballast cars with prime mover and a locomotive with ballast cars to make several test passes prior to first inbound train following morning.

The morning scene ready to receive trains over the structure with the temporary safety walkways installed prior to completing the final wing wall at the structure.

This is the most recent view with the excavation complete. You will notice the modified abutment that is now a center pier between the old and new spans, new conduits for the full length signal cable runs, communication and power cables, the complete construction of concrete wing wall and new abutment of the west end and the structure in place ready for the next central artery contract which widens the southbound lanes of the highway.

Our track work is completed over the structure, some field welds remain, and final preparation on either side for the permanent walkway and permanent ballast protection. As I am told very often, it takes ten percent of the time to do ninety percent of the work and then it takes the other ninety percent of the time to do the last ten percent of the work.



Side view of completed bridge, pier, and abutment.

The MBTA, which is the owner of this railroad, Mass Highway Department, Central Artery Tunnel Project, many consultants, many contractors and Amtrak, the Commuter Rail Operator, all worked together in a tremendous team effort, and I may say in a "partnered" team effort as the partnering process has been instituted with all parties on any of these major work efforts to complete this job without injury, budget problems, or delays to commuter operations. This project was one of the first of what will be many projects related to the massive central artery reconstruction.

Thank you very much.

Mr. Lileikis: Good job, Bob. You realize, of course, that now you have done a little bridgework, you have to become a member of the B&B Association.

Our next presentation will be Metric Systems and Railroading presented by Steve Hague of HNTB. Steve has Bachelor's and Master's degrees in civil engineering from Texas A&M. Steve started directly with HNTB in the Dallas office where he gained some highway engineering experience working on the Dallas North Tollway Extension.

In 1992, he decided to get some real good experience and moved to Kansas City where he could do some real railroad work. There he became involved in a lot of bridge design, inspection, rehabilitation, seismic analysis, and metric retrofitting studies while in the Kansas City office. He has worked on various types of bridge designs including regular screen crossings, segmental concrete girders, and also cable stayed bridges. He is also involved in railroad bridge design for the Dallas Area Rapid Transit river bridge and was also very instrumental in the design for the Joppa Subdivision bridges that Don Steele spoke about yesterday. Please welcome Steve Hague. (Applause)

THE METRIC SYSTEM AND RAILROADING

Steve Hague

Bridge Engineer
HNTB

Thank you and good morning. The title of the program is metric system and railroading, but I think it would be better if we called it inching towards metrics. It is kind of a slow process with some organizations and at the same time, it's a fast process with others.

A couple of years ago, I was asked to develop some plans and some discussions on the metric system as we started looking at doing some metric highway bridges in some of the other parts of the country. At that time, I tried to put together some information on the metric system on some things that had been decided and discussed and some specifics and policies regarding the metric system that may have been in place.

Two years ago, none of that had happened in the highway business and there were a lot of decisions still to be made. People are not sure yet even today what is going on with the metric system and where it is all going to shake out. So when I tried to figure out some of the that information and when I tried to develop some more with the railroad industry for this project, I was pretty unsuccessful in finding out any policies that had been made.

Therefore, I have taken a little bit different approach and decided that I would focus on why the government has decided that the United States should convert to the metric system and what we need to do to make the transition successful.

When I first began the project, I wondered why do we need to go metric? In the transportation industry, in the roadway business, and in the railway business, what difference does it make whether we use the metric system or the English system? We are not going to box up a bridge and ship it overseas to sell it to the Japanese. It doesn't make any difference in international commerce how wide our roads are and whether we use 100-foot stations for measuring roadways and pavement or railroads either.

However, what I did determine is that if we don't make a conversion to the metric system as a whole, the entire country, then we will continue to have cars that have some English and some metric bolts. You can read publications where some of the information is given in the English system with metric in parentheses or vice versa. Things would be backwards.

So what I want to do is spend the next few minutes to describe how the United States got to the metric system and what we need to do to properly use the metric system if the decision is made to convert.

We need to start historically and go back to 1787 when the United States Constitution was written. The Constitution empowered Congress to fix the standards of weights and measures. This was done because the people who wrote the Constitution realized that if there wasn't a standard measurement system in the country, we would have nothing but chaos when we tried to conduct business either within the country or with other countries.

Later in 1790 when he was the Secretary of State, Thomas Jefferson recognized that we should go to a decimal system of units in this country rather than the feet and inches that we use right now with a factor of 12. At that time, the metric system didn't exist and the metric system wasn't developed until 1799 when a commission of French scientists was charged with the selection of a standardized system of measurements. That system, developed by the French, was to be easy to understand and readily reproducible based upon standard definitions. The system became widely used in scientific circles. By 1821, President John Quincy Adams recognized that this country should go ahead and convert to the metric system at that time.

Well, that didn't work, did it? In 1866, Congress finally made the first statutory acknowledgment of the metric system when they passed a law which made the metric system legal for anybody who wanted to use it. If you wanted to conduct business in the metric system, that was okay with Congress. In 1875, an international conference was held and the United States participated in it. At that time, they established the International Bureau of Weights and Measures. It established its home near Paris, France, and began the process of establishing international standards to be used in global commerce. Yet, this country still doesn't use it although we participated over 100 years ago in a conference to establish that.

Although the conference first met from 1875, it wasn't until 1889 that a general conference established the international standards for length and mass. At that time, they established platinum iridium alloy bar of a given length and they defined that as a meter and a cylinder the same alloy of a given mass and they called this a kilogram. Those became the international standards. Prototype copies of the official standards were prepared for each member country of the conference.

The following year, President Benjamin Harrison accepted the prototype standards for the meter and kilogram for the United States. In 1893, the National Bureau of Standards adopted metric units as the standards to legally define the yard and the pound. So since 1893, the metric system has been what we are using. They define the foot, the yards, the pound, all are measured as a fraction of the metric system.

Over time, additional units were required and scientific method measurements were added and advanced and the metric system more defined. In 1960, it was redefined as the

International System Units or SI from the French and that was adopted as the international standards. Eleven years after that, the National Bureau of Standards published a document called, "Metric America — A Decision Whose Time Has Come." The recommendation from that document was presented to the Congress. As a result, on December, 23, 1975, President Gerald Ford signed the Metric Conversion Act of 1975 which committed the United States to a coordinated voluntary conversion to the metric system.

Since 1975, the government, as well as most of us, have determined that voluntary conversion doesn't work too well. So in 1988, Congress passed on the Best Trade and Competitiveness Act and that act is mandated that each federal agency, by a certain date and to an extent economically feasible by the end of fiscal year 1992, use the metric system of measurements in its procurements, grants, and other business-related activities except to the extent that such use is impractical or is likely to cause significant inefficiencies or loss of markets to the United States' firms. Well, that's certainly a mouthful and most people have used that as an out to not go to the metric system.

It should be noted that neither the 1975 or the 1988 Acts require any organization, state, local government, or its people to convert to the metric system. What they anticipate happening is the federal government will go metric and because they spend so much money and have so much business with our organizations, that everybody will be forced to follow along after them.

In July of 1991, President George Bush signed Executive Order 12770. This Executive Order required each federal agency to develop plans for metric conversion and they had to have that plan published by November of 1991. Not only that, but they expected that everybody have a specific timetable for conversion to the metric system.

That brings us to the metric system today. The Federal Highway Administration plans call for complete conversion for everything that goes to construction after September, 1996. The government accounting office and the people in charge of government buildings have already almost fully converted and there is a lot of construction that has already happened for the federal government in the metric system.

So what exactly is the metric system? It is called a system of coherent units and a coherent system of units. A system units is a system in which equations between numerical values have exactly the same form as their corresponding quantities thus there is no need to apply additional factors to find the relationship between those various quantities. By this, we mean that if you want an area quantity in the metric system, you take a length in meters times another length in meters and you come up with square meters. In the English system, you could take the same two lengths measured in feet multiply them together and get a quantity in acres. To get that quantity in acres, then you have to apply the additional factor of 43560 square feet or an acre which makes an acre a non-coherent quantity.

The metric system is based upon three classes of units. There are seven base units. These are the meter, kilogram, second, ampere, candela, mole, and kelvin. These are the base units from which all other units are derived. Supplementary units are radians and steradian which are angular measures that the International Conference has determined are derived dimensionous quantities and don't really fit in with base units or derived units either. The derived units are everything else that you get by multiplying or dividing the base and supplementary units together. This would be like meters per second or kilogram per cubic meter or something like that.

The bad news for those of us who aren't familiar with the metric system is there are 27 units that we need to become familiar with. The good news is that 13 are already in general use. Seimens is new in name only. It's a unit of conductance and it has previously been called the mole. The gray, the becarol, and the mole don't really have any use in the railroad, highway, or construction business so we don't have to worry about them. Kelvin and degrees Celsius both measure temperature. Degrees Celsius is the preferred method of measuring

temperature rather than absolute numbers of kelvin.

The jewel, weber, the testlin and the lux only have limited applications in our business. This leaves us with the meter, kilogram, newton, pascal and degrees Celsius that we need to learn. So it's really not going to be as difficult as people make it out to be.

As we convert to the metric system, we will also need to be familiar with metric conversions and there are two types of conversions. Soft conversions are conversions in which existing number pound units is referred to in its metric equivalent. A good example of that would be bridge ballast. We use HB 12 by 53 piles. In the metric system, these are known as HB 310 by 79. The 310 is the depth of the pile in millimeters like the 12 is in the English system and the 79 is the mass of the pile in kilograms per meter. The name will change, but the section won't. It will be the same shape. You can go around right up to a HP 1253 and not have any difference.

To show that it's not a hard number when you measure it, it will actually be 299 millimeters deep, not 310 millimeters deep. If you measure one now, you will find it's eleven and three quarters inches instead of 12.

Par conversions, on the other hand, are conversions in which the existing inch pound unit are converted to a rational convenient metric value. In other words, it will physically change the dimensions of whatever it is that we are looking at. A good example of that would be studs in normal building construction which right now are placed at 16 inch centers. Sixteen inches converts to 406 millimeters and it becomes inconvenient when you start making large numbers of measurements such as 406, 812, 1218, et cetera. These numbers will probably be converted to a 400 millimeter stud spacing for a physical change in the spacing of studs by about a quarter inch.

In 1964, ASTM Materials Committee E43 on Metric Practices published a metric practice guide which has since been standardized document E380 to provide guidance for the application of the international system of units. The E380 is a document that tells you what you would want to know about the metric system including conversions, calculations, prefixes, style and usage.

In addition, in 1978 committee E6 on Performance of Building Construction published document E621 to provide a single comprehensive and authoritative standard for SI units to be used in the construction application. Together these two documents can be used to cover just about everything that anybody would want to know about the metric system. If you are going to start a metric project, it is recommended that you acquire these two documents and understand what it is that they say.

There are other metric guidelines available and other ASTM standard recommendations from organizations such as ASCE, Institute of Transportation Engineers, Associated General Contractors, and publications by Ashto and AISC as well as guidelines developed by your various state DOTs and others. Not all these recommendations and guidelines are compatible. Some people disagree with some organizations. Some organizations disagree with other organizations and the way things ought to be done. But they are all out there and these guidelines can be taken and looked at and studied and considered.

Either way, if we go metric, we are going to be current. We are going to have to be able to use the system. In order to do that, how do we do it? Well, the general usage of metric terms isn't different from the way we use English terms. They are the same. It is just a different number and different measure. We can use either symbols or spell units when we write metric terms. In general, we don't use commas to separate numbers over 1,000 where a comma would normally be used to recognize a space. Separate every third digit by a space. The spaces in the metric system are acceptable on both the left and the right sides of the decimal point to separate groups of three digits.

We don't attach subscripts or other identifiers to unit symbols. I believe it's habit for a lot of places to put ACV for alternating curve voltage, but it's recommended that you don't

attach a subscript to the symbols because it could change the meaning of the symbols. When using symbols, we need to always use upright type and that is the recommendation by ASTM no matter what type face you are using on your document. You capitalize metric symbols only in accordance with the standards prefixes. The prefixes for numbers over ten and under ten are similar. Some of the metric symbols for the units are similar. For example, a millisecond is a lower case M and a lower case S. If you use a capital M and a capital S, you get megaseimens which is whole different unit and takes on a completely different meaning.

It is recommended that we always leave a space between the quantity and the unit symbol. No spaces are used between the prefixes and the unit symbol so kilometer is a km without a space between them. In multiplication, this should be represented with a raised dot or a hyphen and division with a slash or negative X when we write the terms.

For written units, we need to always treat SI units as common nouns. The exceptions to that are plurals found in the English grammatical form. The exception to that are degrees Celsius where degree is always plural and Celsius is always capital. Lux, hertz, and seimens retain their form in both the singular and plural if you ever need to use them.

We represent multiplication with a space and division with the word "per" when we are writing the units out. If we are going to prepare plans in the metric system, we need to be consistent with units. It is recommended that you put one note on the plan that says all units are in millimeters unless noted otherwise and put all units in millimeters. Carrying numbers beyond millimeter to a fraction of a millimeter is not recommended. Most of you use a mechanical pencil with half millimeter lead in it and you can tell by the size of the head that using a fraction of a millimeter is just way too much precision for what we do.

We need to separate digits with spaces rather than commas. One of the advantages to that is when we reduce full size plans to half size to put in storage. For record copies, you don't have to worry about whether the number has a comma or decimal point. When you get the space you can identify very quickly that it is in millimeters and the space helps you separate meters from millimeters very rapidly.

Normally, areas are given in square meters although large land areas may be measured in square kilometers or hectares. Volume is generally given in cubic meters except for liquid measure and liters are often used for that. The only other exception that I can think of in metric plans is the elevations. These are normally given in meters rather than in millimeters.

If you intend to convert to the metric system, the National Institute of Building Science has published a short booklet entitled "Metric Guide for Federal Construction" which has written a service of practical introductions of the metric conversion. This guide provides recommendations on SI construction, metric usage, specifications, management training.

MBIS makes these points: First, it takes the top level commitment. If your organization is considering converting to the metric system or if you are going to try metric out on a project, then the commitment has to come from the top.

There is a cost associated with metric conversion and it's a real cost. It's going to cost time and it's going to cost training inefficiencies. You are going to have to build libraries and distribute data. If you are building something, you are going to have to buy metric tapes. You are going to have to be prepared to survey in metric. So there are a lot of costs associated with that.

If the people at the top who are most interested in the bottom line of the organization are not committed to it, then the metric conversion isn't going to happen. Additionally, they recommend a schedule for conversion. The metric schedule needs to make sure that you know who you are going to train and when you are going to train if you are going to try a pilot project and you are going to be fully converted to the metric system.

You need to acquire metric publications. There are several publications and newsletters that provides insight to the metric system and metrication in the United States.

What is going on with the building industry? What is going on with the highway

industry? Suppliers will provide information in both English and metric. A lot of their information is already in dual units but they may have separate metric and English publications. So there are a lot of publications available which will help with the metric process.

With regards to training objectives, you need to determine to what extent the metric system will be trained based on what your project requirements are and the people that you have to work with on the project. Everybody doesn't need to be an expert in the metric system. You may have secretarial staff who are typing specifications and those people may be interested only in the correct grammatical usage and spellings of metric.

The technicians who are preparing the plans need to have an idea for what the magnitudes of the numbers are or what the degree of accuracy is that they get by dimensioning something to the nearest millimeter or nearest five millimeters. Your engineers need to be familiar with correct usage and magnitude. They need to know what size of metric material is available and what strength of metric materials are available as well as material code requirements. So there is a lot that the engineers need to know, but even so, not everybody needs to be fully familiar with the metric system right away.

They also identify a variety of training needs. They specifically lay out three training needs which are awareness training, management training, and implementation training. I think today is probably a good example of awareness training. Identify to your people that the metric system is out there and that this country is moving toward the metric system. There is not a lot of fan fair, but all projects which have federal money in them are now are going metric and there is more of and more of them every day.

In addition, management training and implementation training of management training involves establishing a policy for metrication. Establish metric goals, organize training specific groups, and promote the metric system from within the organization. Management training and your managers have to be ready to go metric and have to be behind it all the way for it to be successful.

Implementation training involves the actual training of the individual performing the work in the metric system. What you need to do there is train people enough to become just as efficient in the metric system as they are in the English system. You don't need to overtrain them. Just get them to where they can use it.

In construction, that may not be very much. Carpenters will have to pull their tape and make a chalk line and make their cuts. Concrete finishers don't have a lot to learn. Surveyors, for the most part, have instruments that are all electronic and they can push a button and convert it to the metric system. One of the things I didn't note earlier is that although metric angles are measured in radiants, it is anticipated that all surveying angles will still be measured in degrees, minutes, and seconds.

As this country converts to metric, we all need to learn to think metric. That is not going to be that difficult I think for most of us because it has already happened. We all know what a two-liter bottle of pop is and we all know what 35-millimeter film is. We all know what a four-liter engine is in a car. So thinking metric is something that can happen if we just do it over time and become familiar with the packaging. That's all it is packaging. Most of this has become second nature to us. We know how many two-liter bottles we need to buy for a party so those are things that we can become familiar with and become used to working with.

We also need to monitor the metrication program to ensure that both the training and the implementation of the metric program follow the schedule that we have set out and that we are meeting the training needs and training objectives that we have set forth.

In summary, I would like to say that metrication in the United States is going to provide everybody in this country with a lot of challenges, mostly the engineers and contractors who have to build the public works. We are going to have to become familiar with the system and excel at the things we do best and provide quality engineer services quality construction projects to meet our clients' need.

Ultimately, if you are going to convert to the metric system, you need to determine within your own company when and if metric conversion is appropriate. But if you determine that it is, you can't meet the challenge with a "why metric?" attitude. You have to just wake up and say that, yes, we are going to convert to metric. That is where we are going to be and let's just do it. Thank you. (Applause)

Mr. Lileikis: That was an interesting presentation, Steve.

Our next presentation is Fiber Optic Damage Prevention and our presenter is Terry Zachman. Terry is employed by Sprint Long Distance and started with Sprint as an outside plant engineer. He transferred into fiber optics where he assumed the responsibilities as fiber restoration supervisor for the southeast region.

In 1993, Sprint began a damage prevention program and Terry established and implemented that program on the eastern region of the United States. Terry's title is cable awareness coordinator and he is based in Atlanta, Georgia. Terry is currently vice-chairman of the National Common Carriers Cable Hazards Prevention Committee.

Assisting Terry is Berle Sawyer, manager of fiber operations and maintenance of Sprint's eastern region fiber optic network based in Chicago.

Please welcome Terry. (Applause)

FIBER OPTIC DAMAGE PREVENTION

Terry Zachman

Cable Awareness Coordinator
Sprint

I would like to thank Mike Bradley who assisted us to get on the program this year and we sure welcome the opportunity.

Before we go into these slides, I would like to say that we are a part of the National Common Carrier Group. We work proactively together not only as the long distance company, but as the local company. We have found out that if we show a united front in all the endeavors that we do throughout the industry, not only to the railroads but to contractors as well throughout the country, we have found there is a benefit in reducing damages to all types of facilities.

We are not here to sell anybody anything. We are here to ask you to call before you dig. We just want the opportunity to be notified that, in fact, somebody is going to be digging near our facility. Give us the opportunity to send a locator out, locate the facility, mark it, work with your folks and with the contractors on railroad rights-of-way. We will do anything that we can to assist. Just give us the opportunity to at least show up.

The things we are to go through are, of course, the National Common Carrier Cable Hazards Prevention Committee and then the cable awareness mission statement that we have developed through the national committee, regional cable awareness, cable cut histories, the FCC reportable outages, and Berle will be coming up to explain a little bit about what mandates we have to live by with the federal government on reporting reportable outages. Then we will discuss the Sprint fiber cuts by type, and we have a little graph on that.

Railroad contributions to total cuts gives you an idea of the percentage of railroad cuts that we have had. Fiber operation productivity data that is basically going to be going into our field technicians and what their activities are through year-to-date of 1995. Of course, the data comes up for 1994. Current action with the railroad and what we are doing today and what we would like to do in the future.

Of course, that's the name of the National Committee that we developed to partner in damage prevention seminars, safety meetings, and contract events. We try to get to anybody who has any excavating equipment or plans to do any excavating along fiber optic networks across the United States.

This just gives you an idea of the members of the National Common Carrier Group: American Telephone and Telegraph as you all know, GT Telephone is the local operations and then they started GT Telecom, which is their new long distance group, MCI Communications, Southwestern Bell, Sprint, and Worldcom, which used to be WillTell. Then the LDDS purchased WillTell and now they have become WorldCom.

At this time, I would like to introduce a couple of people. Rod Miller with AT&T is a contact rep out of the State of Ohio. Rod has worked with the Great Lakes common carrier group to help get it established and is currently with that group. Also with us at this conference is John Stodder, who a lot of you know. John works actively with all the railroads for Sprint but is a contract negotiator out of our headquarters in Kansas City. There is an MCI representative, Rich Wolf, but I don't see him. These are the three sustaining members here today and, of course, you all know Consolidated Rail Corporation as Conrail, CSX Transportation, and Union Pacific. They have worked very actively with us throughout the National Common Carriers to give us ideas as to how we can partner with railroad folks.

We want to do anything we can to get the word out about calling before you dig and we found out that if we worked closely with the people that we lease rights-of-way from throughout the United States, the partnership benefits all of us.

This is the mission statement that we came up with. It's a communications link between excavator and ferry, plant owner, and operators. The cable awareness program is a safety program. We look at it as safety because we carry a lot of voice and data. People don't understand the effect that disruption could have — even on their personal lives. Of course, we are customer oriented just like all the railroads. The only difference is we transport voice data and video. We all transport consumable goods for your customers. So there is a relationship there that we are transporting, just like you people, and that's where the partnership comes in.

Now to reduce the cost. We want to reduce the cost of going out and repairing the facility, getting it back up, getting our cost customers back up traffic on-line. What we told them that we would supply is a reliable network. Of course, your repairs are in replacing the track and getting the track back up and getting those trains traveling again.

To stress regional cable awareness through the National Common Carriers, we have set up regional groups throughout the United States. We have tried to divide them up fairly well. We deal with small sections of states. Of course, I would like to say that AT&T started the cable awareness program. Soon thereafter, WorldCom became involved and then MCI and Sprint was one of the laggers. We realized a necessity to get involved with cable awareness. So like the other companies, we made videos and we have them available if anybody would like them. We will share them with anybody. They are just a five to seven-minute video that explains the necessity of calling before you dig.

Within our company we adopted a cable route program. There is desire throughout the technician ranks to protect the facilities. We take a lot of pride in protecting it. So we just called it Adopt A Cable Route Program.

We have a lot of good information that we do pass out that really explains what we are all about as far as calling before you dig issues. All of you have seen the warning markers. What we try to do with government agencies is to work on state and federal levels, but we

start with cities and municipalities because if you can get it done with local issues, if you can work with local folks, we found out that we get a lot more response.

We do the safety awareness presentation in conjunction with our meetings. The contact with our organizations is the transportation department. They are a thorn in everybody's side here as well as your own.

Regarding building and planning, if we can get up front in the design of projects that they have coming up, it has been very beneficial in working with these groups.

Water management pertains usually to cities, counties, or is municipality owned so we work with the water groups within those government agencies.

There are contractors who do their work for them. We work towards general public awareness. Of course the technician route control segment is more than surveillance. When technicians do not have a demand on locating activity, electronic failures, or whatever it may be; in their quiet times we ask them to do surveillance.

Trade shows just like this one are things we do all over the United States.

We call it one-call advertising. It is kind of misleading. Of course, there are construction companies. We like to work with the local one-call agencies. They have been proactive in setting up things like contractor dinners, contractor breakfasts, and contractor meetings.

Through these meetings and throughout the United States we have tried to get railroads to participate. Land developers are a very active digging group. Engineering and planning firms are another and if we can get up front and realize what these utilities are going to do as far as crossing our facilities, then we have an opportunity to protect that facility prior to their construction start.

Agriculture contractors is another group of interest. Unlike our company, some of the other long distance companies traverse across farm lands, all types of agricultural properties. So we feel there is a need there to notify the agricultural contractors that, in fact, there are facilities that cross the farm lands in the United States besides gas companies and transmission pipelines.

We do a little awareness raising for them because if we are helping them, in return they are going to help us through the damage prevention program. Of course, with land surveyors, if we get in the front with their planned activities then we have a better opportunity to guarantee the survivability of our fiber optic networks throughout the United States.

Regarding railroad companies, the beginning of 1994 is when we really got proactive as a group in doing railroad safety meetings. The local safety meetings that the railroads hold on the local basis is where we have been going to do safety presentations. It has been doing us a lot of good.

You are going to see in Berle's report that railroad cuts have fallen off when we started the program of becoming involved in the railroad safety programs. We do give handouts. We attend the meetings and, of course, by doing that and showing the roadmasters that we want to be active with the safety meetings, we get very good contact lists out of the railroads.

At this time, Berle is going to go through these next few slides.

(Whereupon there was a slide presentation)

Mr. Murgas: Thank you, gentlemen, for that interesting overview. Our next feature is one I'm sure we all heard about and that's the floods in British Columbia. Please join me in welcoming John Unsworth, manger of bridge and structures construction for CP Rail.

1995 SPRING WASHOUTS IN BRITISH COLUMBIA

John Unsworth

Manager of Bridge and Structures Construction
CP Rail

Introduction

A flood event on June 6 and 7, 1995, resulted in extensive damage to CP Rail System track and structures in southeastern British Columbia. Watercourse discharges, with peak flows estimated in the order of a 200 year return frequency event, were caused by heavy localized precipitation on June 6 in combination with a rapid snow melt in local mountains. Dikes, including one at Sparwood, BC, designed in 1988 to 200 year return frequency flood event standards were damaged and breached by the June 6 flood.

Preliminary data revealed that about four inches of rain fell over a 15-hour period on June 6 and a snowpack of about 3 feet thick (water equivalent of about 14 feet) existed at an elevation of 5,900 feet at Fernie, BC. The rapid depletion of the snowpack due to and in conjunction with the heavy precipitation resulted in the large run off volumes and subsequent damaging flows in the Elk River Valley of southeastern British Columbia.

The flood event stream flows caused washouts at 44 locations on CP Rail System's Cranbrook, Fording River, and Byron Creek subdivisions. The flood damage ranged in scope from minor bank and bridge substructure scouring to complete loss of subgrade and bridge supports. In addition, heavy localized precipitation resulted in debris torrents depositing materials on the tracks at four locations. These subdivisions are critical transportation links in Canada's coal export market, as CP Rail System transports about 25 MGT of coal from the mines of southeastern BC to west coast terminals on an annual basis. Prompt restoration of service on these lines, particularly the Fording River subdivision and Cranbrook subdivision west of Sparwood that service four mines was of paramount importance.

Repairs on the Byron Creek subdivision were arranged by the mining company serviced by the line at Corbin, under the supervision and guidance of CP Rail System engineering personnel. The Byron Creek subdivision restoration involved about 4,000 linear feet of subgrade construction over nine locations (about 1,500 feet at mileage 7.7) requiring fill and/or rip rap placement. Washouts occurred behind the substructures at five bridges on the Byron Creek Subdivisions. These bridges, constructed in 1977 on pile foundations, remain intact with only restoration of the embankment required. Also, a debris slide deposited an estimated volume of 200 cubic yards of material at mile 10.3 on the Byron Creek subdivision. The remaining 33 sites on the Cranbrook and Fording River subdivisions were apportioned into five project segments in order to best meet the challenge to restore train operations within seven days on priority segments of the line and within four weeks at other locations.

Emergent Reconstruction: Priority Work Sites

Priority work sites, consisting of the bridge at 36.67 Cranbrook and 21 other locations were established for locations west of mile 17.7 on the Cranbrook subdivision and on the Fording River subdivision in order to restore coal service to four mines on the Fording River Subdivision. The challenge facing CP Rail System services personnel was to effect reconstruction in order to establish coal train operations over the line segment within seven days.

The work consisted of embankment reinforcement at 18 locations, 9 at bridge crossings, removal of material from debris torrents at three locations and the reconstruction of the bridge at mile 36.67 Cranbrook subdivision. Seven locations west of mile 29.9 Cranbrook subdivision, four bridges and three embankments, excluding the bridge at mile 36.67, required only the securing of bridge substructures and the subgrade with rip rap transported

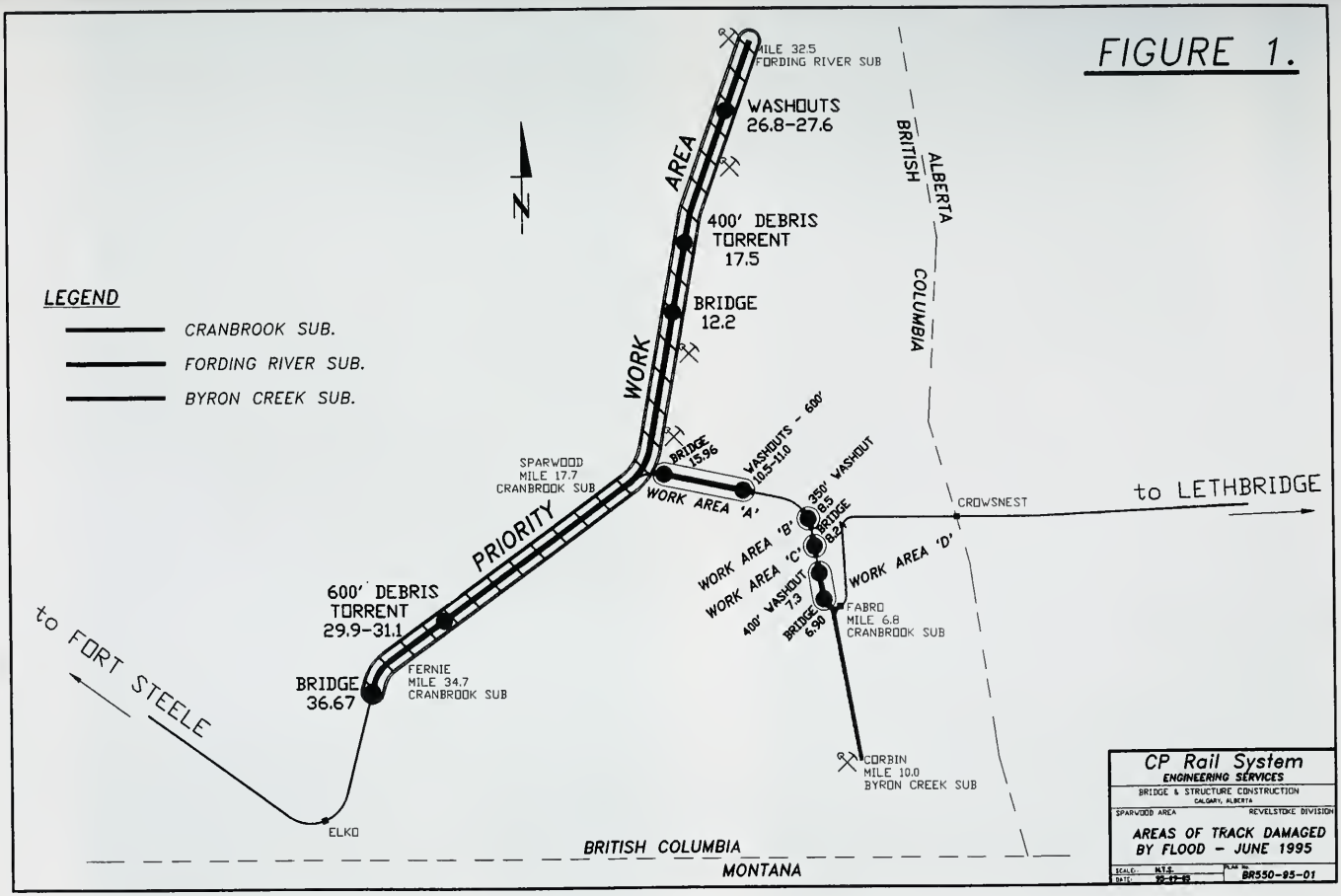


FIGURE 1.
LEGEND
CRANBROOK SUB.
FORDING RIVER SUB.
BYRON CREEK SUB.
MILE 32.5
FORDING RIVER SUB
WASHOUTS
26.8-27.6
400' DEBRIS
TORRENT
17.5
BRIDGE
12.2
WORK AREA
PRIORITY
BRITISH COLUMBIA
ALBERTA
BRIDGE
15.96
WASHOUTS - 600'
10.5-11.0
SPARWOOD
MILE 17.7
CRANBROOK SUB
WORK AREA 'A'
350' WASHOUT
8.5
BRIDGE
8.24
WORK AREA 'B'
WORK AREA 'C'
400' WASHOUT
7.3
BRIDGE
6.90
WORK AREA 'D'
CROWSNEST
to LETHBRIDGE
FABRO
MILE 6.8
CRANBROOK SUB
600' DEBRIS
TORRENT
29.9-31.1
to FORT STEELE
BRIDGE
36.67
FERNIE
MILE 34.7
CRANBROOK SUB
ELKO
CORBIN
MILE 10.0
BYRON CREEK SUB
BRITISH COLUMBIA
MONTANA
CP Rail System
ENGINEERING SERVICES
BRIDGE & STRUCTURE CONSTRUCTION
CALGARY, ALBERTA
SPARWOOD AREA
REVELSTOKE DIVISION
AREAS OF TRACK DAMAGED
BY FLOOD - JUNE 1995
SCALE: N.T.S.
DATE: 95-12-18
PLAN No. BR550-95-01

to the sites by railway airdump cars and placed with loaders and excavators.

Two sites on the Cranbrook subdivision also required the use of loaders and dozers to remove an estimated 600 cubic yards of material deposited on the tracks from debris torrents. This work, except for the restoration of service over the bridge at mile 36.67 Cranbrook subdivision, was completed within three days of the flood event.

Work required on the Fording River subdivision consisted of nine locations, five bridges and four embankments, requiring revetments reinforcement (concrete lock blocks and rip rap), one site of debris torrent material removal (estimated as 12,000 cubic yards) and two sites between miles 26.8 and 27.6 requiring fill placement from local sources, ballasting and surfacing. The debris flow potential at mile 17.5 Fording River subdivision is well documented and a slide detector fence was installed in 1993. The fence was breached on June 6, activating signals indicating the line was out of service, and debris removal commenced the next day. The bridge at 12.2 was intact, but with piles in the pier exposed over a distance of about 15 feet. Pier stability became a concern due to the existence of a shale rock shelf only 20 feet below the underside of the pier footing, into which the piles were suspected to be socketed.

Without the bridge at 36.67 Cranbrook open, it was necessary to divert the river and salvage local materials from the river bed in order to reconstruct the embankment around the bridge pier. Also, ballasting and surfacing of washed out track could not be completed until the bridge at mileage 36.67 Cranbrook subdivision was restored into service to allow ballast work trains and surfacing equipment access to the sites.

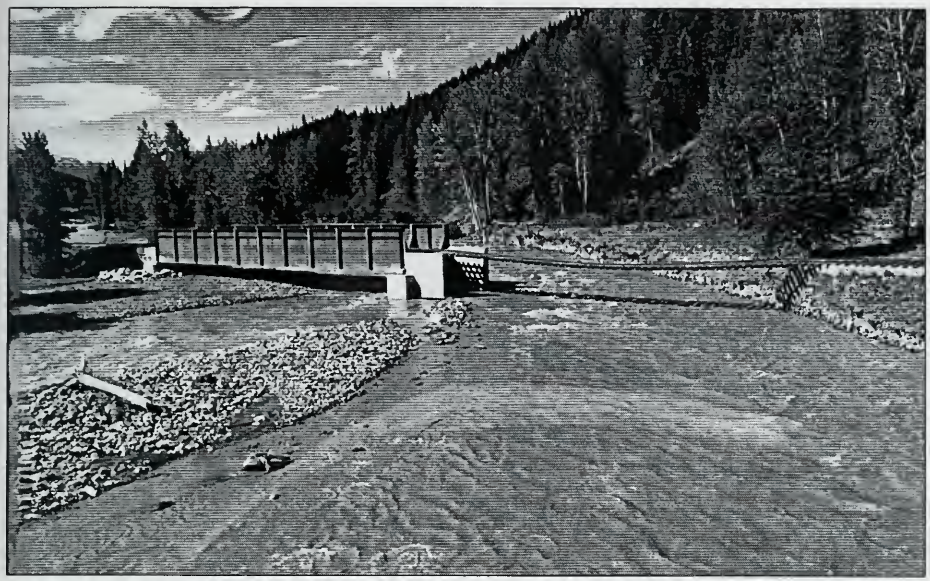
reconstruction required at mile 36.67 Cranbrook subdivision. The bridge at 36.67 Cranbrook subdivision is a 100-foot through plate girder (TPG) span supported on concrete abutments constructed in 1910. The 23-foot tall abutments were constructed on spread footings founded on rock-filled timber cribs. On June 6, the bridge experienced a complete loss of the railway embankment behind the west abutment and the scouring of the west abutment foundation. As a result of this footing undermining, the west abutment tipped an estimated 15 degrees southward. While the substructure was damaged beyond repair, the superstructure, even though twisted along its length remained undamaged due to the flexibility afforded by the open plan (stringer/floorbeam) floor system between relatively stiff girders.

It was decided to remove the west abutment and effect a temporary reconstruction scheme which would render the bridge serviceable as soon as possible and enable the reconstruction of a new permanent reinforced concrete abutment under traffic. Temporary timber crib substructures were constructed with a temporary steel flanking span. The following is a synopsis of the temporary reconstruction sequence.

- Construct access roads and crane pad (a 360-ton capacity crawler crane was mobilized in order to lift the 320,000 lb. through plate girder span and be available for use at two other bridge sites on the Cranbrook subdivision).
- Construct foundation (compacted pit-run crushed rock for temporary timber cribs) and construct the temporary timber pier crib to the east side of the failed abutment (a peninsula of large rock and compacted granular fill was constructed in front of the failed west abutment).
- Cut bearing anchor bolts and lift span onto timber pedestals on the temporary timber crib pier (the span was blocked and supported on the tilted bridge seat as pier pedestals were installed). This resulted in a 10 foot cantilevering of the TPG span at the west end, to which the temporary steel flanking span would be connected.

Calculations confirmed that the negative bending moment flexural stresses over the temporary supports and uplift at the east end of the span under live load were within the allowable design stresses of the girder flanges and end anchorages.

- Demolish concrete abutment (accomplished with a hydraulic splitter).
- Construct foundation and temporary timber crib abutment. Backfill temporary timber crib abutment and approach.



Bridge on Bryon Creek Subdivision washed out behind abutment.

Bridge 12.2 Fording River Subdivision with piles exposed at pier.

- Install temporary steel flanking span (a 25 foot steel I-beam flanking span, complete with diaphragms and bracing, was fabricated and assembled at the site with clip angle connections for attachment to the TPG end floorbeam and bearing pads at the other end for bearing on temporary timber crib abutment).
- Install deck (prefabricated and framed at site).
- Complete backfilling, ballast, construct and surface track.

With crews working around the clock, the reconstruction of the bridge at 36.67 Cranbrook subdivision was completed within six days of the flood event and subsequent coal service interruption. The first train proceeded over the reconstructed bridge at 0044 hours June 12 at 5 mph.

Engineering services personnel inspected the reconstructed structure and regular coal train service was resumed. The bridge crossing speed was raised to 10 mph after 14 days of service. The bridge continued to perform well until commencement of the permanent concrete abutment at the end of July, at which time a total cumulative subsidence of two inches at the temporary girder bearings had occurred (the subsidence attributed to a combination of timber crushing and foundation settlement under coal train service with 65,000 lb. axle loads).

Ballasting and surfacing was completed at sites between miles 26.8 and 27.6 on the Fording River Subdivision at about 1200 hours June 12, thereby restoring coal train service on the critical coal route segments on the Fording River and Cranbrook Subdivision west of Sparwood, BC (mile 17.7 Cranbrook Sub). Reconstruction: Work Area Packages "A", "B", "C" and "D"

With priorty work completed and the resumption of coal train operations on the Fording River and Cranbrook Subdivision west of Sparwood established, the remainder of the restoration work was divided into four packages in order to effect an ordered and structured approach to complete the work within four weeks.

Work Package "A"

Work package "A" consisted of sites between miles 8.9 and 16.0 on the Cranbrook subdivision. Flood-related damage occurred to bridges at miles 8.9, 9.2, 9.4 and 15.96; and the railway embankment at three sites between miles 10.5 and 12.5. The bridges at miles 8.9, 9.2 and 9.4 Cranbrook subdivision suffered considerable scouring behind abutment wingwalls but remained intact and operational. However, the bridge at mile 15.96 experienced similar flood related damage as the bridge at 36.67, with the embankment behind the west abutment destroyed and the west abutment footing undermined. The washout and scouring at the west abutment precipitated its total failure as it subsided an estimated eight inches below the pre-flood stream bed. It was decided to reconstruct this bridge as first priority within Work Area "A" in order to allow airdump railway cars with rock and fill to proceed to the sites at miles 10.5, 11.0, and 12.5 on the Cranbrook subdivision.

At 12.5 Cranbrook subdivision, only rip rap was required to stabilize the toe of the embankment. However, at miles 10.5 and 11.0, a combined length of about 350 feet of embankment was completely washed out leaving the track suspended. The embankment was restored, subgrade constructed, and track laid within 12 days of completion of the temporary reconstruction of the bridge at mile 15.96 Cranbrook subdivision.

The bridge at mile 15.96 Cranbrook subdivision is a two span (two 110 foot TPG spans) structure supported on concrete abutments and central pier constructed in 1910 (substructures were repaired and jacketed in 1954). The June 6 flood event caused complete failure of the west abutment and embankment behind the abutment for a distance of about 300 feet after peak flows breached a dike immediately upstream of the bridge. The result was the subsidence of the west abutment and west end of the west TPG span into the river. The west TPG span was submerged over about half its length and displaced downstream about 20 feet at the west end. It was decided to reconstruct the bridge in a similar manner to that underway at

Bridge 36.67 Cranbrook Subdivision failed west abutment.

Bridge 36.67 Cranbrook Subdivision supported on temporary timber crib pier.

mile 36.67. The immediate challenge, however, was to re-route the river under the east TPG span in order to construct the necessary access and crane pad to commence the reconstruction.

A large berm extending from the newly washed out stream bank to the center pier of the bridge was built in order to construct access, pile driving/crane lifting pads and a foundation for a new subgrade embankment over a distance of about 300 feet west of the bridge. The berm was constructed of local materials and protected with rip rap transported by railway air-dump cars to the west end of the site (about 3000 cubic yards was transported to the site). In conjunction with this work, the stream bed under the east span was dredged to accommodate the high discharge volumes in the channel, using excavators in the river upstream and downstream of the bridge.

In order to effect a prompt opening of the bridge at 15.96 Cranbrook to traffic, and allow airdump work trains to transport materials to washed out embankments at miles 10.5, 11.0, and 12.5, a design-construct approach was undertaken commencing June 10. Fourteen piles were driven, capped, and braced to provide a temporary steel bent on which to support the span. The piles were driven in a pattern so they could be incorporated into the final pile plan being designed by CPRS structural engineers. The following construction sequence was generally followed as necessary resources were mobilized from the bridge at 36.67 Cranbrook (in addition to a 40,000 foot per pound rated energy pile driver).

- Construct river training berm.
- Construct access and crane/pile driving pads.
- Drive piles for temporary steel support bent and de-water at location of failed west abutment.
- Construct base of temporary timber crib abutment to south side of west end of the west span and channel runways (Blocked to the pier and berm for support) to south side of center pier.
- Install sliding devices in channel runways (Hillman Rollers), remove anchor bolts and install safety cables in TPG spans.
- Lift west end of west span (span was lifted from lugs with spreader beam as it was not possible to sling underneath submerged end of span).
- With crane at west end and cables attached to a dozer at the east end of the west span, slide span southwards and support west end on base of temporary timber crib abutment. The east end of the span rested on the glide/roller arrangement on timber blocking. The span was moved laterally about 20 feet in this manner to allow for the demolition of the failed abutment, driving of remaining piles for the temporary steel bent, steel bent construction and east end roller bearing inspection.
- Demolish old abutment (drilled and blasted with rubble left in place).
- Construct temporary retaining wall behind location of temporary timber crib abutment to allow embankment construction to proceed concurrently with bridge reconstruction.
- Drive remaining piles for temporary steel bent (some pile locations were coincident with location of failed abutment and abutment demolition required first). Construct temporary steel bent (cut off piles, cross cap, brace and install bearing plates).
- Slide span back into position on pier and temporary steel bent.
- Lift and place base of abutment to position about 25 feet west of the west end of the bridge and complete construction of timber crib and ballast retention wall. Backfill temporary timber crib.
- Install prefabricated steel I-beam flanking span.
- Install pre-framed deck (complete with safety railings) on flanking span, perform minor steel repairs (torn stringer top flange angle temporarily reinforced with welded cover plate until final steel repairs) and install new TPG deck ties in place of damaged ties on TPG span.
- Construct subgrade and track. Ballast and surface.

Bridge 36.67 Cranbrook Subdivision. Temporary reconstruction completed.

Bridge 36.67 Cranbrook Subdivision. Span supported on temporary steel bent and formwork for permanent abutment being constructed.

In addition to damage to the top flange angles of a stringer in the west panel of the west span, inspection of steel work revealed damaged intermediate web stiffeners and web plate on the south side of the west end of the west TPG span. Immediate repairs were made to the stringer flanges with other steel repairs being deferred, as it was determined the span was in acceptable condition to carry train loads at 10 mph commencing June 18.

The movement of airdump cars with materials over the bridge at 15.96 Cranbrook enabled the next phase within Work Area "A" to proceed and the embankment, subgrade, and track at miles 10.5, 11.0, and 12.5 Cranbrook subdivision were reconstructed. The work required at mile 12.5 consisted of rip rap protection at the embankment toe only. However, the sites at 10.5 and 11.0 required extensive grade reconstruction over a combined length of about 350 linear feet to a depth of approximately 25 feet.

During the reconstruction of the bridge at mile 15.96, efforts to construct berms in the river and divert stream flow away from the toes of the proposed embankment slopes were undertaken. With this complete, the dumping and placement of rock fill could proceed.

Concern over embankment foundation conditions (exposed and sloping bedrock) and high water at mileage 10.5 precipitated an investigation into slope excavation and realignment of the track. However, river training was successful and a stable rock foundation was placed enabling embankment reconstruction in its original location. Both embankments at locations at miles 10.5 and 11.0 were restored (large rock foundation with five feet of freeboard above high water level and granular fill placed and compacted), track constructed, ballasted, and surfaced by June 30. Rip rap was transported and deposited at locations where minor scouring occurred behind wing walls at bridges 8.9, 9.2, and 9.4 Cranbrook subdivision, thus completing (except for placement of rip rap at the bridges) the Work Area "A" project and opening this portion of the subdivision to traffic. Slow orders of 10 mph will remain on the bridges until the permanent reconstruction is completed, and on reconstructed subgrade until roadmaster's inspections reveal no further subsidence and surfacing requirements under load (after about 500,000 gross tons has passed over the affected areas).

Work Package "B"

Work package "B" consisted of a washed out section of track at mile 8.5 Cranbrook subdivision. A 350 foot long section of the railway subgrade was scoured away to a depth of about 20 feet leaving the rails and ties of the 6 degree curved track hanging over the washed out embankment. In order to open this segment of track concurrently with those of work packages "C" and "D" (comprising the bridge at 8.24 and washed out subgrades at miles 6.9 and 7.3 Cranbrook subdivision), thereby restoring service on the Cranbrook subdivision east of Sparwood, BC (mile 17.7 Cranbrook subdivision), materials were transported to site by road commencing June 20 (river training completed and track removal began June 14).

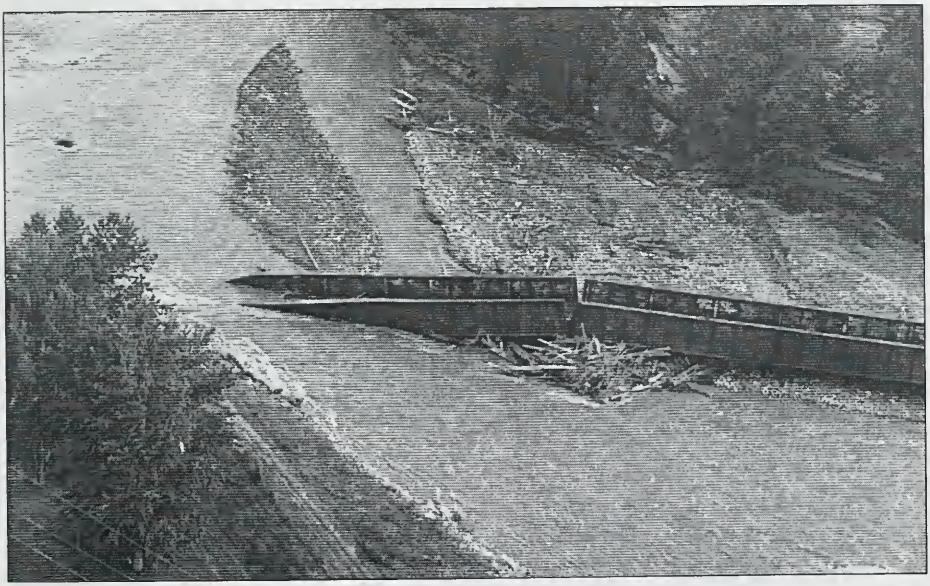
Embankment reconstruction in lifts from imported rock and granular fill materials was completed by June 30. Track construction, ballasting, and surfacing was completed July 3 concurrent with the temporary reconstruction of bridge 8.24 Cranbrook.

Work Package "C"

The bridge at 8.24 Cranbrook subdivision suffered extensive damage from the flood event river discharges of June 6. Similar to the flood damage experienced at bridges 15.96 and 36.67 Cranbrook subdivision, the railway subgrade west of the bridge and the west abutment of the bridge were washed away by the flood waters. This 103 foot TPG span erected in 1910 on concrete abutments on spread footings was lying in the river at an angle with its west end about 70 feet downstream. The west abutment had tipped into the river bed due to scour at the footing and the east abutment bridge seat and ballast wall were damaged when the span was pulled downstream as the west abutment failed.

Access for heavy construction equipment, such as the 365 T crawler crane and 40,000 foot per pound pile driver, as limited by a steep, and possibly unstable, slope (the roadway

Bridge 36.67 with permanent abutment constructed.



Bridge 15.96 Cranbrook Subdivision washed out at west end.

elevation adjacent to the bridge site is considerably higher than the track). Construction of an access road on this slope was not an option due to potential slope instability (piezometers were noted in the slope and the soils were wet from recent rains) and difficult grades for transport of the crawler crane components.

To provide the necessary access, the track structure was moved aside and the railway subgrade widened to the west of the bridge to access the roadway at a location with an elevation similar to the track. With this access constructed, equipment for the construction of a berm to re-channel the river to its former location (the berm took the form of an island as high flows made it necessary to allow for discharge behind the west abutment location) was constructed. The failed west abutment was located, drilled and blasted to allow for pile driving for a temporary support bent and the proposed new abutment. The bridge deck was removed in panels with the crane to lighten the span, enable an inspection of the floor system, and permit evaluation of damage to the deck. As expected, many ties were destroyed by debris and required replacement.

Adequate lead time for the design of the proposed permanent abutment pile layout enabled the driving of all piles for the final abutment. Reconstruction followed the following procedure:

- Construct access, river diversion berms and crane pads.
- Demolish abutment
- Erect crane and remove bridge deck.
- With the extent of berm construction constrained by river flows and the difficult span position, the crawler crane could not lift the 230,000 lb. TPG span at a boom radius necessary to lift the span at its center. A lifting arrangement consisting of the 360 T crane lifting at the west end of the span, such that a 200 T capacity auxiliary locomotive crane could lift at the east end floor beam of the span, was designed.
- The span was lifted onto blocking on the berm at the west end and onto a prefabricated timber pad under the northeast corner to position and stabilize the span; as well as enable cable slings to be installed at the east end floor beam (the blocking was placed under the northeast corner in high river flows and was installed with stabilizing cables to a dozer while being positioned with an excavator bucket while the northeast corner of the TPG was lifted with the crawler crane).
- Safety cables were installed along the TPG interior knee braces.
- The east abutment was repaired by epoxy injection of cracks and removal/reconstruction of failed concrete on the bridge seat and ballast retention wall.
- All piles were driven for the permanent abutment with the central 16 piles being cut off at elevations to allow for the construction of a steel temporary support bent with wide flange section caps, steel shims and bracing.
- Temporary bearings of timber blocking, steel plates and angles were field constructed and installed at the east abutment.
- With the locomotive auxiliary crane at the east end and the crawler crane at the west end of the span, the cranes working in tandem lifted the superstructure into position on the repaired east abutment and temporary steel bent at the west end. The locomotive crane lifted its rated capacity of 35 T at a boom radius of 50 feet from the track on the east abutment, leaving the crawler crane to lift 80 T with a 60 foot boom radius (about 90 percent of rated capacity at radius of 60 feet).
- A temporary timber crib abutment (with dimensions to provide adequate safety factors against bearing pressure, sliding and overturning) and a 25 foot temporary steel flanking span were fabricated and erected.
- The deck was prefabricated in panels (damaged ties were replaced) and installed on the superstructure.
- The fill behind the temporary timber crib abutment was constructed and track construction, ballasting, and surfacing operations ensued once the subgrade was restored on the access road west of the bridge.

Bridge 15.96 Cranbrook Subdivision being lifted and moved laterally on to temporary supports.

Bridge 15.96 Cranbrook Subdivision Temporary reconstruction completed.

Inspection of the steel work revealed only minor damage to knee brace angles and some loose rivets (which appeared to have been a pre-existing condition due to evidence of "bleeding" at rivet holes). Steel repairs were assessed as non-critical and would be performed after the span was in service.

The work at 8.24 Cranbrook proceeded well and was completed within 16 days; five days ahead of the original projection date of July 7. The lift of June 28 was accomplished by careful scheduling of Work Package "D" as it was necessary to complete the work at miles 6.9 and 7.3 Cranbrook subdivision in order to mobilize a locomotive crane from Calgary (east of flood sites).

Work Package "D"

Work package "D" involved the restoration of washed out subgrade at miles 6.9 and 7.3 Cranbrook subdivision.

The bridge at mile 6.9 is TPG span on concrete abutments with pile foundations. The bridge remained intact during the flood, but about 100 feet of the railway embankment behind the west abutment was washed out. The river was re-channeled into its former position and the embankment reconstructed with large rock transported by airdump cars and local materials salvaged from river diversion. Work commenced on June 12 and was completed within five days in order to allow completion of the embankment reconstruction work at 7.3 Cranbrook by June 25.

At mile 7.3 Cranbrook subdivision, about 500 feet of the subgrade was destroyed to a depth of 25 feet during the June 6 flood conditions. With river flow rechanneling completed on June 20, embankment and subgrade reconstruction commenced. Embankment materials were transported to the site by airdump cars and local material salvaged from river training exercises.

Concluding Remarks

Train operations were completely restored on the Cranbrook and Fording River subdivisions on July 2 with inaugural eastbound train CP6048 arriving at Crowsnest at 20:35. The restoration of service on critical coal service lines (Fording River sub and Cranbrook sub west of mile 17.7) on June 12 and east of mile 17.7 Cranbrook sub by July 2 exhibited the CP Rail System engineering services' commitment to customer service.

In conjunction with the customers of CP Rail System transportation services, the Byron Creek subdivision work was completed on July 28. The challenge of rail service restoration on critical coal routes within seven days and within four weeks on the remainder of the lines affected by the June 6 flood in southeast BC was accomplished by CP Rail Systems engineering services personnel in a timely and cost-effective manner.

Permanent reconstruction of abutments at bridges 8.24, 15.96 and 36.67 Cranbrook, as well as some rip rap reinforcements, remain in order to lift slow orders and resume normal operating speeds on the coal route.

The work of permanent reconstruction at 36.67 Cranbrook commenced the week of July 3 with the driving of piles for the abutment (piles were driven between the temporary steel flanking span stringers after ramp construction for placing the pile driver leads), construction of a temporary steel bent and removal of the timber crib pier supporting the bridge since June 12.

Construction of formwork, reinforcement placement and concrete pouring around the temporary steel bent and foundations piles (cut off above ground elevation at three feet and six feet for back row and front row piles, respectively) proceeded under traffic.

After concrete curing to a compressive strength of about 4,000 psi, bearing installation, removal of temporary steel flanking span, and concrete pour completion (ballast wall pockets); backfilling, track construction, ballasting and surfacing will be performed to restore the bridge to normal operation. The work of dike restoration and revetment protection of the dike

Bridge 15.96 Cranbrook Subdivision with formwork for permanent abutment constructed.

Reconstruction of subgrade at mile 10.5 Cranbrook Subdivision.

and new abutment will be coordinated with municipal, provincial and federal agencies responsible for land, water, environmental and fish habitat protection.

The bridges at miles 8.24 and 15.96 Cranbrook subdivision are being permanently reconstructed in a similar manner as the bridge at 36.67 Cranbrook subdivision (sheet pile cofferdams were required due to the water levels and depth of new foundations).

At 15.96 Cranbrook subdivision, an additional 11 piles were driven for permanent abutment (abutment pour commenced September 18). Land remediation, dike restoration, and revetment protection also remains at bridge 15.96. This work will be performed in coordination with local, provincial, and federal agencies. All permanent works are anticipated to be complete by October 1995.

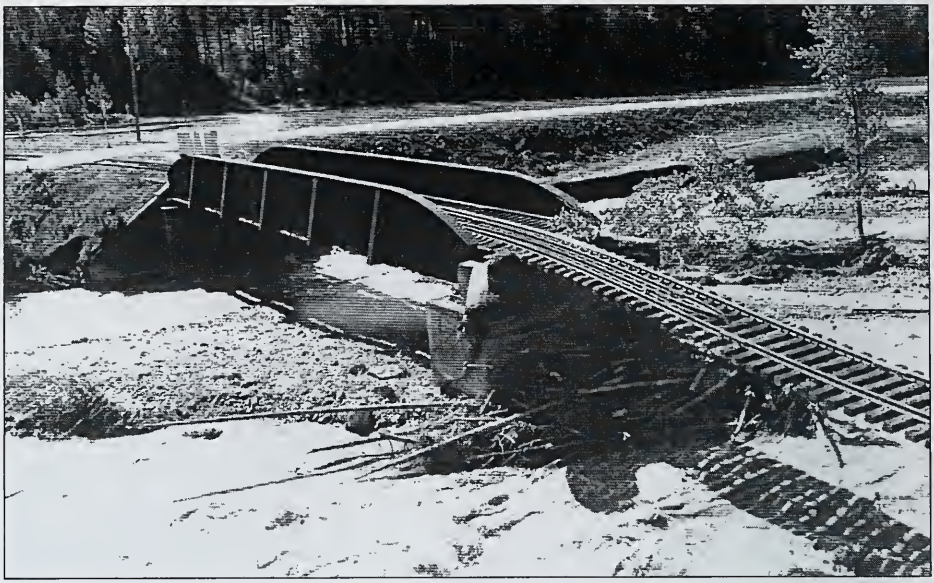
Projects such as this test the technical substance of engineering personnel and the financial resources of the company. Successful planning and execution of this emergent response project was accomplished due to the dedicated efforts of all operating, engineering, and transportation personnel engaged in this reaction to an interruption of customer service.

Thank you. (Applause)

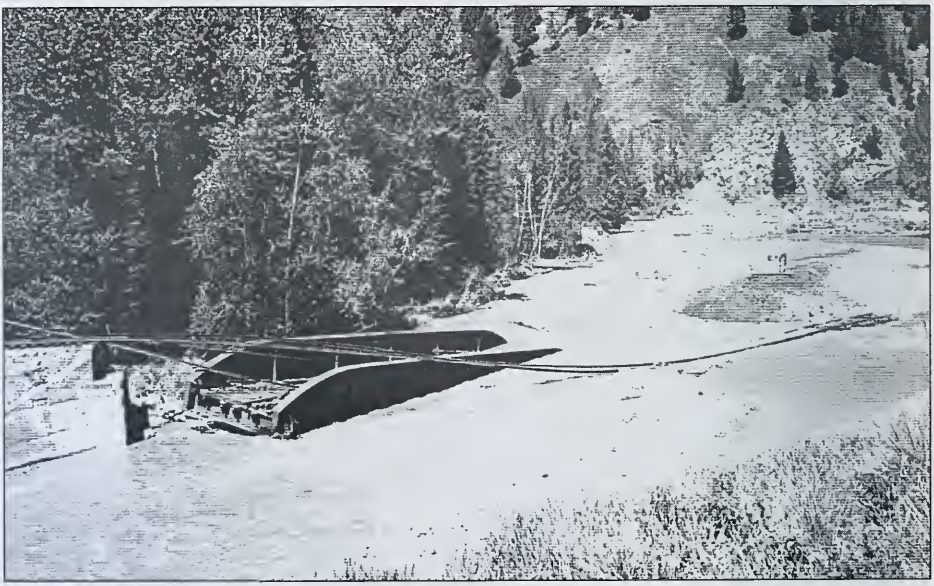
Washed out embankment at mile 11.0 Cranbrook Subdivision.

Washed out embankment at 8.5 Cranbrook Subdivision.

Restoration of track at 8.5 Cranbrook Subdivision completed.



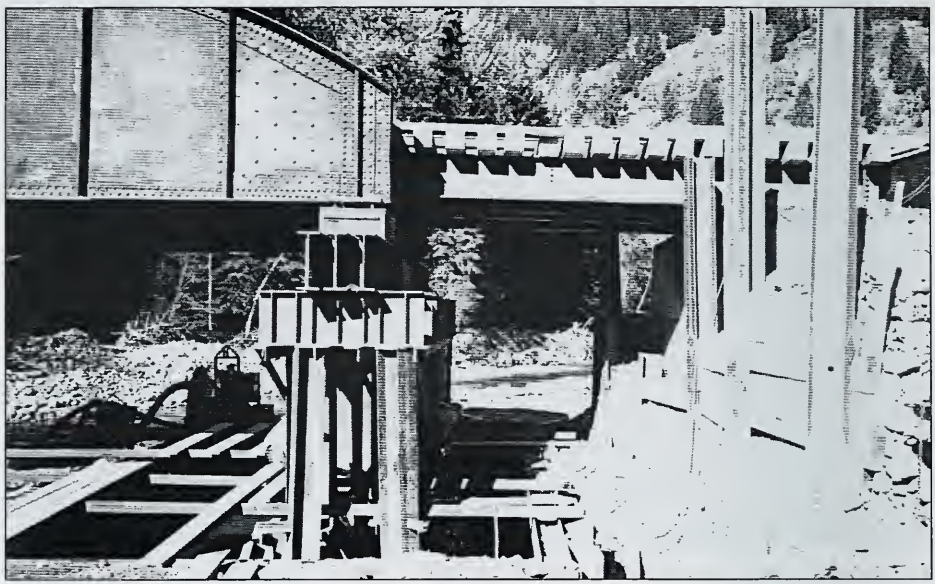
Bridge 6.90 Cranbrook Subdivision washed out behind west abutment.



Bridge 8.24 Cranbrook Subdivision West abutment failed and span displaced due to washout.

Bridge 8.24 Cranbrook Subdivision being lifted on to repaired east abutment and temporary steel bent.

Bridge 8.24 Cranbrook Subdivision. Temporary reconstruction completed.



Bridge 8.24 Cranbrook Subdivision with cofferdam for permanent abutment footing constructed.

President Nordlund: Thank you, John, for sharing that with us.

I would like to thank Pete Murgas and Joe Lileikis for all of their work in putting together the organization of the presentation. That was the last of the formal ones and you had a good audience, John. This was very interesting.

At this time I would call on the outgoing directors of the Roadmasters Association. Would Ron Poulsen on completion of his term of treasurer come forward and Dave Kelly on completion of his term as a director please come forward. On behalf of the Association, I would like to present plagues to Ron and Dave recognizing their participation and support over the past years. (Applause)

President Van Huis: At this time I would like to call the outgoing directors from the Bridge and Building Association. Would Lee Hostler, Jimmy Neece and Ron Kaye please come forward. On behalf of the B&B Association and myself, I certainly would like to thank these guys for the support they have given during the year. Thank you. (Applause)

President Nordlund: This board of directors doesn't have a cushy job. They do have to work behind scenes.

Next on our agenda is the report of resolution and this will be read by Pete Murgas.

RESOLUTION STATEMENT

Having reached the closing of the Annual Joint Conference of the Roadmasters and Maintenance of Way Association and the American Railway Bridge and Building Association, and being deeply indebted to all those members and friends who have contributed their time and effort to make our conference a success, it is right that we should acknowledge this indebtedness and that it be so entered in the minutes of the meeting.

Be it further resolved that our deep appreciation be extended to those who have honored our Associations with their presence and by their informative addresses. Those include Jack McBain, senior vice-president operations, CN North America; Ed Burkhardt, president and chief executive officer, Wisconsin Central Transportation Corporation; James Denn, commissioner, Minnesota Department of Transportation; Gordon Davids, Federal Railroad Administration; Jim Pinkerton, Union Pacific; Preston Sargent, Union Pacific; Tim Galarnyk, Lunda Construction; Mike Boyer, Applied Engineering & Science; Rick Briggs, KCS; Don Steele, Union Pacific; George Andreas, Conrail; David Levy, Frederick R. Harris; Richard Calhoun, CTE; David Barrett, Modjeski and Masters; Steve Hague, HNTB; and Steve Lounsberry, REMSA; who did a fine job in bringing us up to date on innovations in the rail industry, and to all the committee chairmen and sponsors who, with the loyal cooperation of the committee members, prepared the interesting and instructive reports that were presented.

Be it further resolved that a very special thanks is expressed to Steve Lounsberry, president of REMSA and all members of the Railway Engineering - Maintenance Suppliers Association for the fine reception and the hospitality we enjoyed during our conference.

Our thanks are also expressed to Mrs. Florence Nordlund, Mrs. Suzanne Van Huis, Frances Dachs, and the committee members for their efforts in arranging registration and entertainment for our wives.

A special thanks goes to Pat Weissmann and Barbara Marlow. Without their unselfish assistance, these two Associations would have great difficulty functioning.

Be it finally resolved that both Associations express their heartfelt thanks to our retiring presidents, Keith Nordlund and John Van Huis, who have spent so much time and effort into guiding the activities of our two Associations with great efficiency and dedication during the past year.

I move this resolution be adopted.

Respectfully submitted

Peter W. Murgas.

President Nordlund: Thank you, Peter. At this time, I would like to call upon the immediate past presidents of both Associations, Gene Schubel and Don Steele, for the installation of officers.

Mr. Schubel: Thank you, Keith. The following are the names of the officers-elect of the Roadmasters and Maintenance of Way Association for the year of 1995-1996. The officers named please step forward in front of the podium and take a position on my left.

President, Kendall Koff, senior engineer track and structures, Amtrak. First vice president, Wayne Russell, general director roadway maintenance and planning, Burlington Northern Santa Fe. Second vice president, Ron Poulsen, senior project manager, HDR Engineering. Treasurer, Darrell Cantrell, engineer of track, Burlington Northern Santa Fe.

Directors with terms expiring in 1996 include Al Cloutier, division engineer, Amtrak; Reuven Shiloh, director engineering planning and support, Conrail; and Peter Murgas, manager of reengineering, Norfolk Southern.

Directors with terms expiring in 1997 include Ray Brosseau, manager track programs,

CP Rail; Bob Davis, production manager ties, Southern Pacific; and Dwight Clark, director of quality management engineering, Union Pacific.

Directors with terms expiring in 1998 include Bob King, superintendent engineering maintenance, CP Rail; Tom Long, manager engineering services, Indiana Harbor Belt; and Joe Riley, engineer standards, Metra.

New directors with terms expiring in 1999 include Dave Griffith, assistant division engineer, Norfolk Southern; Chris Dodge, chief engineer, RailTex; and Andy Sensing, assistant engineering superintendent, Illinois Central.

I will now turn the podium over to Don Steele to introduce his board.

Mr. Steele: The following are the officers-elect of the American Railway Bridge and Building Association for the administrative years 1995-1996.

Would the officers so named please stand up and take a position in front of the podium.

President, Mike Bradley, project engineer, Conrail. Senior vice president, Joe Lileikis, senior engineer structures, Amtrak. Junior vice presidents, Bob Carter, B&B superintendent, Burlington Northern Santa Fe, and David Franz, bridge engineer, Kansas City Southern. Treasurer, Don Lewis, assistant engineer structures, Illinois Central.

Directors with terms expiring in 1996 include Mark Johnson, manager of structures, Burlington Northern Santa Fe; Tim Rich, Engineer B&B, Conrail; and Dale Bartholomew, senior project manager railroad facilities, Sverdrup Corporation.

Directors with terms expiring in 1997 include Pat Barrett, engineer construction and maintenance, Burlington Northern Santa Fe; Dave Cook, superintendent B&B, Montana Rail Link; and Dick Dummar, manager architectural design, Union Pacific.

Our new directors with terms expiring in 1998 include Richard Calhoun, associate, CTE, Willie Benton, engineer structures, Norfolk Southern, and Bill Gemeiner, manager methods and research, Union Pacific.

Mr. Schubel: As officers of our Associations you will represent to the general public the true meaning of roadway maintenance and construction and railway bridge and building. You will be our joint voice in the industry which will make you our common bond with railroad personnel everywhere.

Mr. Steele: As officers in our Association, you will represent our best interest in any of our activities or projects always reminding yourself that your attitude must be part in every undertaking sanctioned by your respective Associations. In this, you will be adhering strictly to the constitution and bylaws of our respective Associations. As a representative of the B&B Association, I install you in the office to which you have been elected.

Mr. Schubel: As a representative of the Roadmasters and Maintenance of Way Association, I install each of you into the office to which you have been elected.

Please remain standing so Don and I can come down and congratulate you. Please show your appreciation for these gentlemen by your applause. (Applause)

President Nordlund: Thank you. At this time I would like to call upon Steve Lounsberry, president of the REMSA Association to come to the podium.

Mr. Lounsberry: President Nordlund and President Van Huis, REMSA congratulates you both on your superb handling of the business and policy affairs of your proud Associations. Our Associations have enjoyed closeness over the many years of their existence and a great deal of the credit of the longevity of the groups has to do with being guided by men of excellence and with the desire to do the right things and men with vision.

Both of you gentlemen fit that description. It has been a pleasure to work with both of you. As an expression of REMSA's lasting esteem and appreciation, I would like to present each of you with a plaque to commemorate your year of service as president.

Keith, congratulations. John, congratulations.

Now, because REMSA knows that every president must have a gavel, we have provided one for each incoming president. Would Mike Bradley and Ken Koff please come forward.

I know that being an officer and going through the ranks teaches a great deal, but it does not begin to prepare you for the onslaught of details and decisions that have to be made when you become president of an Association. But now it's too late. (Applause)

Thank you very much. We have confidence in your abilities as do your members that you will continue the proud tradition of your memberships. We just hope you don't have to bang the gavel so hard that the head flies off as has happened in Congress recently when a chairman was trying to get control of the rowdy members on the floor. Congratulations and best wishes, gentlemen, from REMSA. (Applause)

President Nordlund: As for Kendall Koff, as part of the tradition in Roadmasters, we have a president's pin and it is an honor to present you with that also.

Mr. Koff: Thank you.

President Nordlund: With that, I will turn the microphone over to the new president.

President Koff: Thank you, Keith. Keith, in deep appreciation of your service for Roadmasters as president, we have a plaque commemorating your year of service. Thank you. (Applause)

Mr. Nordlund: Thank you very much. (Applause)

President Koff: If I remember Gene Schubel mentoring us through on how to do a good job in closing as president, one of his comments was to be brief and I certainly will.

Most of you know me. I have been associated with the board almost nine years. I had no idea that I would have an opportunity when I joined Roadmasters in 1981 to serve as president. To say I am honored for that privilege would be an understatement.

The railroad that I was originally with in 1981 was supportive of Roadmasters. But they had 52 roadmasters and I was a new one, so I wasn't always one of them that was selected to attend the annual conference. But as I was headquartered in Waukegan, Illinois, it was a short train ride to Chicago and it was very easy to buzz in and attend a conference.

By attending, I learned a little bit that a new roadmaster doesn't have a chance to if he is just out on his home road kicking spikes and running gangs. One of the things I learned is we have a lot of commonness in this industry. The problems weren't unique to any one road. They were shared by all roads in some way. I also learned that my road, in some cases, was leading on many issues. In some, we weren't leading, we were being led.

I couldn't have found out that if I was only on my own road and without that contact. So I learned that there were some common problems and some uncommon solutions to our collective problems. I also developed a new network of people to draw on, some of them with REMSA, and some of them with other railroads, and some of them with the B&B Association. These men and women also provided an opportunity for me to pick up a phone and call and ask for assistance when it was needed. I did that a number of times.

I have also seen that as I started my 21st year in this industry, my phone rings sometimes and younger men call me and ask a question. That network has been useful to me and I hope in some way I have been useful to those who have thought to call on me.

I credit Roadmasters with giving that experience and knowledge and that network to me and to the other men and women who are associated with our groups.

The changes in our industry seem to be picking up steam. There has been no absence of change in this industry and I certainly don't suggest that there is going to be any slowing. As a matter of fact, I think it is going to be more rapid. So the information Roadmasters has to exchange with our leaders today and future leaders is even more valuable. But it doesn't stop just with the network of people or experience or professional growth.

There is a chance to participate in this process as a presenter of technical reports, as a member of the audience who hears and gains new knowledge through the technical reports, or by preparing or participating in preparing one. Serving on a committee, and the opportunities available for someone to serve and have an opportunity like I had to serve on this board and to rise through the ranks of the executive committee.

I think participation is the key to receiving a full benefit of membership and I am going to dedicate this year of service to this organization to invite people in for the first time to participate to a greater level. So by saying that, I invite all of you to take a look at the green sheets that are still around. If you haven't signed up for or have never considered signing up for membership on a committee, I invite you to consider it and do it today before you leave.

The other rather important thing that Roadmasters has done is to have a training committee. We have a great number of people who are participating for the first time in this committee. They are really making things happen. They have had good leadership from the start. They have successfully passed the baton twice now to new leadership as chairmen and co-chairmen and this year they did it again. They selected Eric Dahlberg of Amtrak as chairman to lead the efforts on the training committee backed up by Jim Bertrand of the Canadian National. I am very proud of that committee selection. They have two fine individuals and I know we are going to see good things out of this group as they continue.

We do have a new initiative that they have undertaken to bring forward a training package for the mandated track worker safety program. You are going to hear more about that very quickly as we try to fast track this so that the training package is available for those who can make quick and ample use of it as we train our people. So you will be hearing more about that.

Likewise, if training is your interest and you think you could contribute to this group's efforts, I encourage you to call Pat Weissmann at our office and express your interest. She will see to it to it that it gets to the right people so that it is known that you have an interest in contributing to this group.

Finally, as we near the end of this conference, I would like to tell you that the process is already in place for us to plan our conference for next year. We make appointments within the boards and each board member has a job that drives both the business of running this organization and producing the conference. Each one of these jobs is important. Each member of the board is dedicated and dedicates some of his time to it. But some jobs are behind the scenes and somewhat hidden from view and each one of these are important. Some are on the forefront and very obvious to the group like Pete Murgas on the Roadmasters side acting as conferences chairman. That is the guy who is in the limelight. All the other jobs are just as important, but he is out front because he helps bring forward our conference. So it's an important job.

With that, I want to tell you that I have selected Dwight Clark to serve as next year's conference chairman. He is with the Union Pacific and served on the board with us three years. I am looking forward to Dwight helping replicate the success that we have enjoyed this year.

With that, I wish you all a safe and pleasurable trip home and I thank you all again for your selection of me as your president. I hope to see you all in Chicago next year. Thank you very much. (Applause)

President Bradley: We have a plaque for John Van Huis honoring the work that he did in the last year. As many of you know, being involved with the Association takes a lot of work. We have had great presentations and a great conference and John worked diligently all last year doing that. I think he made it a success. I would consider myself successful if I am able to meet even half of what he has done. (Applause)

I also have similar remarks to Ken's and they're going to be brief. It is always fortunate to go second in these cases because he said most of what I wanted to say.

It is true that when you get up to this level it's very honorable to move in as president of the Association. Many of you are familiar with the people who make up these organizations and they are quite talented and there is a host of qualified people out there.

It is truly an honor to stand up here today. I would be remiss if I did not acknowledge, however, the fact that the reason that I am standing up here is because I work for a corporation that supports these types of events.

I became a member in 1982, but I was not quite active until about 1987. At that time, John Kapp, who was one of our system engineers in construction, encouraged me to go on the board and I did take that opportunity. At that time, I didn't realize the value that I do today.

There are many times when there were questions whether we would be able to attend and I got strong support, too, from our chief engineer, Jerry Cossel. That has meant a lot to me to get to know a network and the people within the association.

To reiterate some of what Ken said, I encourage participation. It will do you a wealth of good in the knowledge that you gain not only through networking, but in your own research.

The B&B Association has grown by leaps and bounds in probably the six or eight years that I have been with it. During that time, John Horney started the seminars which have really made the B&B more noticeable in the community. Those seminars have taken off, starting in 1991 with the seminar on contracting to the ones we now hold on bridge inspection. We are now going to start a bridge repair seminar. I think that has been valuable information for our associations.

Lastly I would like to recognize the directors and vice presidents who are on the board. They are quite qualified and they work diligently in presenting and developing a conference. I look forward in this next year to working with them and I look forward to a successful year. I hope to see everyone in Chicago in 1996. Thank you. (Applause)

I would like to adjourn this meeting and close. Thank you. (Applause)

(Meeting adjourned)

First row: **Bob Carter, Joe Lileikis, Mike Bradley, Pat Weissmann**
Second row: **Pat Barrett, Tim Rich, Don Steele, Don Lewis, Lee Hostler, Ron Kaye, Jimmy Neece**
Third row: **Dave Cook, Dale Bartholomew**

Past Officers

	1891–1892	1892–1893	1893–1894	1894–1895
President	O. J. Travis	H. M. Hall	J. E. Wallace	Geo. W. Andrews
1st V.-Pres.	H. M. Hall	J. E. Wallace	Geo. W. Andrews	W. A. McGonagle
2nd V.-Pres.	J. B. Mitchell	G. W. Hinman	W. A. McGonagle	L. K. Spafford
3rd V.-Pres.	James Stannard	N. W. Thompson	L. K. Spafford	James Stannard
4th V.-Pres.	G. W. Hinman	C. T. Fuller	E. D. Hines	Walter G. Berg
Secretary	C. W. Gooch	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	George M. Reid	George M. Reid	George M. Reid	George M. Reid
Executive Members	W. R. Damon	G. W. Andrews	Q. McNab	James Stannard
	G. W. Markley	J. M. Staten	A. S. Markley	James H. Travis
	W. A. McGonagle	J. M. Caldwell	Floyd Ingram	J. H. Cummin
	C. W. McGehee	Q. McNab	James Stannard	R. M. Peck
	G. W. Turner	Floyd Ingram	James H. Travis	J. L. White
	J. E. Wallace	A. S. Markley	J. H. Cummin	A. Shane

	1895–1896	1896–1897	1897–1898	1898–1899
President	W. A. McGonagle	James Stannard	Walter G. Berg	J. M. Cummin
1st V.-Pres.	L. K. Spafford	Walter G. Berg	J. H. Cummin	A. S. Markley
2nd V.-Pres.	James Stannard	J. H. Cummin	A. S. Markley	C. C. Mallard
3rd V.-Pres.	Walter G. Berg	A. S. Markley	G. W. Hinman	W. A. Rogers
4th V.-Pres.	J. H. Cummin	R. M. Peck	C. C. Mallard	J. M. Staten
Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	George M. Reid	N. W. Thompson	N. W. Thompson	N. W. Thompson
Executive Members	R. M. Peck	W. O. Eggleston	G. J. Bishop	Wm. S. Danes
	L. J. White	W. M. Noon	C. P. Austin	J. H. Markley
	A. Shane	J. M. Staten	M. Riney	W. O. Eggleston
	A. S. Markley	G. J. Bishop	Wm. S. Danes	R. L. Heflin
	W. M. Noon	C. P. Austin	J. H. Markley	F. W. Tanner
	J. M. Staten	M. Riney	W. O. Eggleston	A. Zimmerman

	1899–1900	1900–1901	1901–1902	1902–1903
President	Aaron S. Markley	W. A. Rogers	W. S. Danes	B. F. Pickering
1st V.-Pres.	W. A. Rogers	W. S. Danes	B. F. Pickering	C. C. Mallard
2nd V.-Pres.	J. M. Staten	B. G. Pickering	A. Shane	A. Shane
3rd V.-Pres.	Wm. S. Danes	A. Shane	A. Zimmerman	A. Zimmerman
4th V.-Pres.	B. F. Pickering	A. Zimmerman	C. C. Mallard	A. Montzheimer
Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	N. W. Thompson	N. W. Thompson	N. W. Thompson	N. W. Thompson
Executive Members	T. M. Strain	T. M. Strain	A. Montzheimer	W. E. Smith
	R. L. Heflin	H. D. Cleaveland	W. E. Smith	A. W. Merrick
	F. W. Tanner	F. W. Tanner	A. W. Merrick	C. P. Austin
	A. Zimmerman	A. Montzheimer	C. P. Austin	C. A. Lichty
	H. D. Cleaveland	W. E. Smith	C. A. Lichty	W. O. Eggleston
	A. Montzheimer	A. W. Merrick	W. O. Eggleston	J. H. Markley

	1903–1904	1904–1905	1905–1906	1906–1907
President	A. Montzheimer	C. A. Lichty	J. B. Sheldon	J. H. Markley
1st V.-Pres.	A. Shane	J. B. Sheldon	J. H. Markley	R. H. Reid
2nd V.-Pres.	C. A. Lichty	J. H. Markley	R. H. Reid	J. P. Canty
3rd V.-Pres.	J. B. Sheldon	R. H. Reid	R. C. Sattley	H. Rettinghouse
4th V.-Pres.	J. H. Markley	R. C. Sattley	J. P. Canty	F. E. Schall
Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	C. P. Austin	C. P. Austin	C. P. Austin	C. P. Austin
Executive Members	R. H. Reid	W. O. Eggleston	H. Rettinghouse	W. O. Eggleston
	W. O. Eggleston	A. E. Killam	A. E. Killam	A. E. Killam
	A. E. Killam	H. Rettinghouse	J. S. Lemond	J. S. Lemond
	R. C. Sattley	J. S. Lemond	C. W. Richey	C. W. Richey
	H. Rettinghouse	W. H. Finley	W. O. Eggleston	H. H. Eggleston
	J. S. Lemond	C. W. Richey	F. E. Schall	B. J. Sweatt

	1907–1908	1908–1909	1909–1910	1910–1911
President	R. H. Reid	J. P. Canty	H. Rettinghouse	H. Rettinghouse
1st V.-Pres.	J. P. Canty	H. Rettinghouse	J. S. Lemond	F. E. Schall
2nd V.-Pres.	H. Rettinghouse	F. E. Schall	F. E. Schall	A. E. Killam
3rd V.-Pres.	F. E. Schall	J. S. Lemond	A. E. Killam	J. N. Penwell
4th V.-Pres.	W. O. Eggleston	A. E. Killam	J. N. Penwell	L. D. Hadwen
Secretary	S. F. Patterson	S. F. Patterson	C. A. Lichty	C. A. Lichty
Treasurer	C. P. Austin	C. P. Austin	J. P. Canty	J. P. Canty
Executive Members	A. E. Killam	J. N. Penwell	W. Beahan	T. J. Fullem
	J. S. Lemond	Willard Beahan	F. B. Scheetz	G. Aldrich
	C. W. Richey	F. B. Scheetz	L. D. Hadwen	P. Swenson
	T. S. Leake	W. H. Finley	T. J. Fullem	G. W. Rear
	W. H. Finley	L. D. Hadwen	G. Aldrich	W. O. Eggleston
	J. N. Penwell	T. J. Fullem	P. Swenson	W. F. Steffens

	1911-1912	1912-1913	1913-1914	1914-1915
President	F. E. Schall	A. E. Killam	J. N. Penwell	L. D. Hadwen
1st V.-Pres.	A. E. Killam	J. N. Penwell	L. D. Hadwen	G. Aldrich
2nd V.-Pres.	J. N. Penwell	L. D. Hadwen	G. Aldrich	G. W. Rear
3rd V.-Pres.	L. D. Hadwen	T. J. Fullem	G. W. Rear	C. E. Smith
4th V.-Pres.	T. J. Fullen	G. Aldrich	C. E. Smith	E. B. Ashby
Secretary	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Treasurer	J. P. Canty	J. P. Canty	J. P. Canty	F. E. Weise
Executive Members	G. Aldrich	G. W. Rear	W. F. Steffens	W. F. Steffens
	P. Swenson	W. F. Steffens	E. B. Ashby	S. C. Tanner
	G. W. Rear	E. B. Ashby	S. C. Tanner	Lee Jutton
	W. F. Steffens	C. E. Smith	Lee Jutton	F. F. Strouse
	E. B. Ashby	S. C. Tanner	W. F. Strouse	C. R. Knowles
	W. O. Eggleston	Lee Jutton	C. R. Knowles	A. Ridgway

	1915-1916	1916-1917	1917-1918	1918-1919
President	G. W. Rear	C. E. Smith	S. C. Tanner	Lee Jutton
1st V.-Pres.	C. E. Smith	E. B. Ashby	Lee Jutton	F. E. Weise
2nd V.-Pres.	E. B. Ashby	S. C. Tanner	F. E. Weise	W. F. Strouse
3rd V.-Pres.	S. C. Tanner	Lee Jutton	W. F. Strouse	C. R. Knowles
4th V.-Pres.	Lee Jutton	F. E. Weise	C. R. Knowles	A. Ridgway
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Executive Members	F. E. Weise	W. F. Strouse	A. Ridgway	J. S. Robinson
	W. F. Strouse	C. R. Knowles	J. S. Robinson	J. P. Wood
	C. R. Knowles	A. Ridgway	J. P. Wood	A. B. McVay
	A. Ridgway	J. S. Robinson	D. C. Zook	J. H. Johnston
	J. S. Robinson	J. P. Wood	A. B. McVay	E. T. Howson
	J. P. Wood	D. C. Zook	J. H. Johnston	C. W. Wright

	1919-1920	1920-1921	1921-1922	1922-1923
President	F. E. Weise	W. F. Strouse	C. R. Knowles	Arthur Ridgway
1st V.-Pres.	W. F. Strouse	C. R. Knowles	A. Ridgway	J. P. Wood
2nd V.-Pres.	C. R. Knowles	A. Ridgway	J. S. Robinson	J. S. Robinson
3rd V.-Pres.	A. Ridgway	J. S. Robinson	J. P. Wood	C. W. Wright
4th V.-Pres.	J. S. Robinson	J. P. Wood	C. W. Wright	E. T. Howson
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.			F. E. Weise	F. E. Weise
Directors	J. P. Wood	C. W. Wright	E. T. Howson	F. C. Baluss
	A. B. McVay	A. B. McVay	J. H. Johnson	Maro Johnson
	J. H. Johnston	G. A. Manthey	E. K. Barrett	O. F. Dalstrom
	E. T. Howson	E. T. Howson	F. C. Baluss	S. D. Corey
	C. W Wright	J. H. Johnston	Maro Johnson	W. B. Hotson
	G. A. Manthey	E. K. Barrett	O. F. Dalstrom	P. N. Nelson

	1923-1924	1924-1925	1925-1926	1926-1927
President	J. S. Robinson	J. P. Wood	C. W. Wright	E. T. Howson
1st V.-Pres.	J. P. Wood	C. W. Wright	E. T. Howson	F. C. Baluss
2nd V.-Pres.	C. W. Wright	E. T. Howson	F. C. Baluss	Maro Johnson
3rd V.-Pres.	E. T. Howson	F. C. Baluss	Maro Johnson	J. S. Huntoon
4th V.-Pres.	F. C. Baluss	Maro Johnson	J. S. Huntoon	C. S. Heritage
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.	F. E. Weise	F. E. Weise	F. E. Weise	F. E. Weise
Directors	S. T. Corey	J. S. Huntoon	C. S. Heritage	A. I. Gauthier
	W. B. Hotson	A. I. Gauthier	W. B. Hotson	E. L. Sinclair
	P. N. Nelson	E. L. Sinclair	P. N. Nelson	P. F. Dalstrom
	J. S. Huntoon	C. S. Heritage	A. I. Gauthier	W. T. Krausch
	A. I. Gauthier	W. B. Hotson	E. L. Sinclair	R. C. Bardwell
	E. L. Sinclair	P. N. Nelson	O. F. Dalstrom	H. I. Benjamin

	1927-1928	1928-1929	1929-1930	1930-1934
President	F. C. Baluss	Maro Johnson	J. S. Huntoon	C. S. Heritage
1st V.-Pres.	Maro Johnson	J. S. Huntoon	C. S. Heritage	A. I. Gauthier
2nd V.-Pres.	J. S. Huntoon	C. S. Heritage	A. I. Gauthier	H. I. Benjamin
3rd V.-Pres.	C. S. Heritage	A. I. Gauthier	H. I. Benjamin	W. T. Krausch
4th V.-Pres.	A. I. Gauthier	H. I. Benjamin	W. T. Krausch	T. H. Strate
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.	F. E. Weise	F. E. Weise		
Directors	W. T. Krausch	R. C. Henderson	G. A. Rodman	E. C. Neville
	R. C. Bardwell	J. S. Ekey	W. A. Batey	H. H. Best
	H. I. Benjamin	T. H. Strate	F. W. Hillman	J. E. King
	R. C. Henderson	G. A. Rodman	E. C. Neville	A. B. Scowden
	T. H. Strate	W. A. Batey	H. H. Best	W. A. Batey
	J. S. Ekey	F. W. Hillman	J. E. King	L. C. Smith

	1934–1935	1935–1936	1936–1937	1937–1938
President	H. I. Benjamin	T. H. Strate	E. C. Neville	C. M. Burpee
1st V.-Pres.	T. H. Strate	E. C. Neville	C. M. Burpee	F. H. Masters
2nd V.-Pres.	E. C. Neville	C. M. Burpee	F. H. Masters	W. S. Lacher
3rd V.-Pres.	A. B. Scowden	F. H. Masters	C. A. J. Richards	C. A. J. Richards
4th V.-Pres.	W. R. Roof	C. A. J. Richards	W. S. Lacher	F. H. Cramer
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Directors	C. M. Burpee	A. L. McCloy	W. R. Roof	B. R. Meyers
	W. A. Batey	R. P. Luck	T. P. Soule	G. S. Crites
	L. C. Smith	H. H. Best	F. H. Cramer	R. E. Dove
	C. A. J. Richards	W. R. Roof	B. R. Meyers	T. P. Soule
	A. L. McCloy	T. P. Soule	G. S. Crites	A. Chinn
	R. P. Luck	F. H. Cramer	R. E. Dove	L. G. Byrd

	1938–1939	1939–1940	1940–1941	1941–1942
President	Armstrong Chinn	A. E. Bechtelheimer	H. M. Church	R. E. Dove
1st V.-Pres.	F. H. Cramer	F. H. Cramer	R. E. Dove	F. H. Soothill
2nd V.-Pres.	A. E. Bechtelheimer	H. M. Church	F. A. Soothill	G. S. Crites
3rd V.-Pres.	H. M. Church	R. E. Dove	G. S. Crites	A. M. Knowles
4th V.-Pres.	R. E. Dove	F. H. Soothill	A. M. Knowles	N. D. Howard
Sec.-Treas.	C. A. Lichty	C. A. Lichty		
Secretary	. . . . .	. . . . .	F. O. Whiteman	A. G. Shaver
Treasurer	. . . . .	. . . . .	F. E. Weise	F. E. Weise
Directors	L. G. Byrd	B. R. Meyers	N. D. Howard	R. E. Caudle
	W. R. Ganser	W. Walkden	L. G. Byrd	I. A. Moore
	F. H. Soothill	A. S. Krefting	K. L. Miner	W. A. Sweet
	B. R. Meyers	A. M. Knowles	R. E. Caudle	J. L. Varker
	W. Walkden	L. G. Byrd	I. A. Moore	L. E. Peyser
	A. S. Krefting	K. L. Miner	W. A. Sweet	Martin Meyer

	1942–1943	1943–1944	1944–1945	1945–1946
President	G. S. Crites	J. L. Varker	J. L. Varker	N. D. Howard
1st V.-Pres.	R. E. Caudle	R. E. Caudle	R. E. Caudle	F. G. Campbell
2nd V.-Pres.	A. M. Knowles	N. D. Howard	N. D. Howard	J. S. Hancock
3rd V.-Pres.	N. D. Howard	F. G. Campbell	F. G. Campbell	E. H. Barnhart
4th V.-Pres.	J. L. Varker	J. S. Hancock	J. S. Hancock	W. F. Martens
Secretary	A. G. Shaver† Lorene Kindred‡ Elinor V. Heffern	Elinor V. Heffern	Elise LaChance	Elise LaChance
Treasurer	F. E. Weise	C. R. Knowles	C. R. Knowles	C. R. Knowles
Treasurer Emeritus		F. E. Weise	F. E. Weise	
Directors	M. Meyer	W. F. Martens	W. F. Martens	A. B. Chapman
	L. E. Peyser	A. L. McCloy	A. L. McCloy	W. A. Huckstep
	K. L. Miner	L. C. Winkelhaus	L. C. Winkelhaus	F. R. Spofford
	F. G. Campbell	E. H. Barnhart	E. H. Barnhart	Guy E. Martin
	J. S. Hancock	A. B. Chapman	A. B. Chapman	B. R. Meyers
	L. C. Winkelhaus	L. E. Peyser	L. E. Peyser	L. E. Peyser

†To November 1, 1942 ‡To February 1, 1943

	1946–1947	1947–1948	1948–1949	1949–1950
President	F. G. Campbell	J. S. Hancock	E. H. Barnhart	W. F. Martens
1st V.-Pres.	J. S. Hancock	E. H. Barnhart	W. F. Martens	W. A. Huckstep
2nd V.-Pres.	E. H. Barnhart	W. F. Martens	W. A. Huckstep	Guy E. Martin
3rd V.-Pres.	W. F. Martens	W. A. Huckstep	Guy E. Martin	F. R. Spofford
4th V.-Pres.	W. A. Huckstep	G. E. Martin	F. R. Spofford	Lee Mayfield
Secretary	Elise LaChance	Elise LaChance	Elise LaChance	Elise LaChance
Treasurer	C. R. Knowles	C. R. Knowles	L. C. Winkelhaus	L. C. Winkelhaus
Directors	Guy E. Martin	H. M. Harlow	Lee Mayfield	H. M. Harlow
	B. R. Meyers	H. B. Christianson	F. M. Misch	V. E. Engman
	L. E. Peyser	F. R. Spofford	W. D. Gibson	G. W. Benson
	H. M. Harlow	Lee Mayfield	H. M. Harlow	F. M. Misch
	H. B. Christianson	Franz M. Misch	V. E. Engman	L. R. Morgan
	F. R. Spofford	W. D. Gibson	G. W. Benson	J. A. Jorlett

	1950–1951	1951–1952	1952–1953	1953–1954
President	W. A. Huckstep	Guy E. Martin	F. R. Spofford	Lee Mayfield
1st V.-Pres.	Guy E. Martin	F. R. Spofford	Lee Mayfield	H. M. Harlow
2nd V.-Pres.	F. R. Spofford	Lee Mayfield	H. M. Harlow	J. A. Jorlett
3rd V.-Pres.	Lee Mayfield	H. M. Harlow	J. A. Jorlett	R. R. Gunderson
4th V.-Pres.	H. M. Harlow	J. A. Jorlett	R. R. Gunderson	W. H. Huffman
Secretary	Elise LaChance	Elise LaChance	Elise LaChance	Elise LaChance
Treasurer	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus
Directors	F. M. Misch	M. H. Dick	W. H. Huffman	M. H. Dick
	L. R. Morgan	R. R. Gunderson	L. R. Morgan	J. F. Warrenfells
	J. A. Jorlett	J. F. Warrenfells	B. M. Stephens	G. Switzer
	M. H. Dick	W. H. Huffman	M. H. Dick	B. M. Stephens
	R. R. Gunderson	L. R. Morgan	J. F. Warrenfells	W. H. Bunge
	J. F. Warrenfells	B. M. Stephens	G. Switzer	E. R. Schlaf

	1954–1955	1955–1956	1956–1957	1957–1958
President	H. M. Harlow	J. A. Jorlett	R. R. Gunderson	W. H. Huffman
1st V.-Pres.	J. A. Jorlett	R. R. Gunderson	W. H. Huffman	M. H. Dick
2nd V.-Pres.	R. R. Gunderson	W. H. Huffman	M. H. Dick	B. M. Stephens
3rd V.-Pres.	W. H. Huffman	M. H. Dick	B. M. Stephens	H. D. Curie
4th V.-Pres.	M. H. Dick	B. M. Stephens	H. D. Curie	
Secretary	Elise LaChance	Elise LaChance	Elise LaChance	Elise LaChance
Treasurer	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus
Directors	B. M. Stephens	J. F. Warrenfells	W. H. Bunge	G. W. Benson
	W. H. Bunge	H. D. Curie	E. R. Schlaf	J. M. Lowry
	E. R. Schlaf	J. M. Lowry	G. W. Benson	H. H. Matthews
	J. F. Warrenfells	W. H. Bunge	J. M. Lowry	T. M. VonSprecken
	H. D. Curie	E. R. Schlaf	T. M. VonSprecken	W. H. Bunge
	J. M. Lowry	G. W. Benson	H. A. Matthews	E. R. Schlaf

	1958–1959	1959–1960	1960–1961	1961–1962
President	M. H. Dick	B. M. Stephens	H. D. Curie	G. W. Benson
1st V.-Pres.	B. M. Stephens	H. D. Curie	G. W. Benson	J. M. Lowry
2nd V.-Pres.	H. D. Curie	G. W. Benson	J. M. Lowry	E. R. Schlaf
3rd V.-Pres.	G. W. Benson	J. M. Lowry	E. R. Schlaf	H. A. Matthews
Secretary	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg
Treasurer	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus
Directors	J. M. Lowry	W. H. Bunge	H. A. Matthews	R. C. Baker
	R. C. Baker	E. R. Schlaf	M. J. Hubbard	R. H. Miller
	W. H. Bunge	H. A. Matthews	R. C. Baker	Shirley White
	E. R. Schlaf	M. J. Hubbard	R. H. Miller	H. M. Wilson
	H. A. Matthews	R. C. Baker	Shirley White	R. D. Hellweg
	M. J. Hubbard	R. H. Miller	H. M. Wilson	F. W. Hutcheson

	1962–1963	1963–1964	1964–1965	1965–1966
President	J. M. Lowry	E. R. Schlaf	R. C. Baker	H. M. Wilson
1st V.-Pres.	E. R. Schlaf	R. C. Baker	H. M. Wilson	R. D. Hellweg
2nd V.-Pres.	H. A. Matthews	Shirley White	R. D. Hellweg	J. W. DeValle
3rd V.-Pres.	R. C. Baker	H. M. Wilson	J. W. DeValle	W. F. Armstrong
Secretary	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg
Treasurer	L. C. Winkelhaus	E. F. Snyder	E. F. Snyder	E. F. Snyder
Directors	Shirley White	R. D. Hellweg	W. F. Armstrong	J. A. Goforth
	H. M. Wilson	F. W. Hutcheson	J. S. Ellis	E. R. Simmons
	R. D. Hellweg	W. F. Armstrong	J. A. Goforth	N. D. Bryant
	F. W. Hutcheson	J. W. DeValle	E. R. Simmons	A. R. Dahlberg
	W. F. Armstrong	J. A. Goforth	N. D. Bryant	J. S. Ellis
	J. W. DeValle	E. R. Simmons	A. R. Dahlberg	T. L. Fuller

	1966–1967	1967–1968	1968–1969	1969–1970
President	R. D. Hellweg	J. W. DeValle	W. F. Armstrong	J. A. Goforth
1st V.-Pres.	J. W. DeValle	W. F. Armstrong	J. A. Goforth	A. R. Dahlberg
2nd V.-Pres.	W. F. Armstrong	J. A. Goforth	A. R. Dahlberg	T. L. Fuller
3rd V.-Pres.	J. A. Goforth	A. R. Dahlberg	T. L. Fuller	N. D. Bryant
Secretary	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg
Treasurer	W. H. Huffman	W. H. Huffman	W. H. Huffman	W. H. Huffman
Directors	N. D. Bryant	J. S. Ellis	N. F. Lucas	W. H. Rankin
	A. R. Dahlberg	T. L. Fuller	W. L. Short	E. E. Runde
	H. F. Lucas	R. A. Youngblood	C. E. Wachter	T. A. Reynolds
	J. S. Ellis	H. F. Lucas	A. C. Jones	J. J. Ridgeway
	T. L. Fuller	W. L. Short	W. H. Rankin	J. R. Williams
	R. A. Youngblood	C. E. Wachter	E. E. Runde	J. W. Chambers
	V. D. Raessler	A. C. Jones	T. A. Reynolds	R. E. Frame
	W. L. Short	W. H. Rankin	J. J. Ridgeway	J. C. Hobbs
	C. E. Wachter	E. E. Runde	J. R. Williams	

	1970–1971	1971–1972	1972–1973	1973–1974
President	A. R. Dahlberg	T. L. Fuller	N. D. Bryant	E. E. Runde
1st V.-Pres.	T. L. Fuller	N. D. Bryant	E. E. Runde	J. J. Ridgeway
2nd V.-Pres.	N. D. Bryant	E. E. Runde	J. J. Ridgeway	J. R. Williams
3rd V.-Pres.	E. E. Runde	J. J. Ridgeway	J. R. Williams	W. R. Rankin
Secretary	Ann Wilson	Ann Wilson	Ann Wilson	Ann Wilson
Treasurer	W. H. Huffman	W. H. Huffman	W. H. Huffman	W. H. Huffman
Directors	T. A. Reynolds	J. W. Chambers	R. K. Corbett	D. C. Gould
	J. J. Ridgeway	R. E. Frame	J. R. Iwinski	W. S. Stokely
	J. R. Williams	J. C. Hobbs	J. S. Pritchett	W. C. Sturm
	J. W. Chambers	R. K. Corbett	D. C. Gould	J. W. Davidson
	R. E. Frame	J. R. Iwinski	W. S. Stokely	C. A. Hughes
	J. C. Hobbs	J. S. Pritchett	W. C. Sturm	W. R. Hyma
	R. K. Corbett	D. C. Gould	J. W. Davidson	O. C. Denz
	J. R. Iwinsky	W. S. Stokely	C. A. Hughes	R. C. McMaster
	J. S. Pritchett	W. C. Sturm	W. R. Hyma	W. E. Brakensiek

	1974–1975	1975–1976	1976–1977	1977–1978
President	J. J. Ridgeway	J. R. Williams	W. H. Rankin	J. R. Iwinski
1st V.-Pres.	J. R. Williams	W. H. Rankin	J. R. Iwinski	W. C. Sturm
2nd V.-Pres.	W. H. Rankin	J. C. Hobbs	W. C. Sturm	D. C. Gould
3rd V.-Pres.	J. C. Hobbs	J. R. Iwinski	D. C. Gould	J. W. Chambers
Secretary	Ann Wilson	Ann Wilson	Ann Wilson	Ann Wilson
Treasurer	W. H. Huffman	W. H. Huffman	W. H. Huffman	W. H. Huffman
Directors	J. W. Davidson	W. E. Brakensiek	J. W. Chambers	W. J. Gunkle
	C. A. Hughes	O. C. Denz	M. Noyszewski	W. E. Halley
	W. R. Hyma	R. C. McMaster	W. J. Gunkle	K. L. Wammell
	W. E. Brakensiek	F. R. Lindsay	W. E. Halley	J. Budzileni
	O. C. Denz	M. Noyszewski	K. L. Wammel	B. J. King
	R. C. McMaster	W. C. Sturm	J. Budzileni	J. G. Robertson
	F. B. Lindsay, Jr.	W. J. Gunkle	B. J. King	O. C. Denz
	M. Noyszewski	W. E. Halley	J. G. Robertson	E. C. Patterson
	Jim Payne	K. L. Wammel		W. S. Stokely

	1978–1979	1979–1980	1980–1981	1981–1982
President	W. C. Sturm	D. C. Gould	J. W. Chambers	W. R. Hyma
Sr. V.-Pres.	D. C. Gould	J. W. Chambers	R. C. McMaster	O. C. Denz
Jr. V.-Pres.	J. W. Chambers	R. C. McMaster	W. R. Hyma	J. Budzileni
Jr. V.-Pres.	R. C. McMaster	W. R. Hyma	O. C. Denz	J. M. Williams
Secretary	Ann Wilson	Ann Wilson	Ann Wilson	Pat Weissmann
Treasurer	W. F. Armstrong	W. F. Armstrong	W. F. Armstrong	W. C. Sturm
Directors	J. Budzileni	O. C. Denz	J. W. Davidson	D. A. Bessey
	B. J. King	W. J. Gunkle	C. M. Russell	J. N. Michel
	J. G. Robertson	W. S. Stokely	J. M. Williams	P. H. Saletnik
	O. C. Denz	L. D. Green	D. A. Bessey	O. D. Anthony
	E. C. Patterson	C. M. Russell	J. N. Michel	J. T. Kapp
	W. S. Stokely	J. M. Williams	P. H. Saletnik	D. J. Lewis
	L. D. Green	D. A. Bessey	O. D. Anthony	J. W. Davidson
	C. M. Russell	J. N. Michel	J. T. Kapp	H. J. Laga
	J. M. Williams	P. H. Saletnik	D. J. Lewis	A. S. Uppal

	1982–1983	1983-1984	1984-1985	1985-1986
President	O. C. Denz	J. Budzileni	J.M. Williams	D. A. Bessey
Sr. Vice President	J. Budzileni	J.M. Williams	D.A. Bessey	J. T. Kapp
Jr. Vice President	J. M. Williams	D.A. Bessey	J.T. Kapp	D. J. Lewis
Jr. Vice President	D. A. Bessey	J.T. Kapp	D.J. Lewis	R. A. Tallent
Secretary	P. A. Weissmann	P.A. Weissmann	P.A. Weissmann	P. A. Weissmann
Treasurer	P. H. Saletnik	P.H. Saletnik	P.H. Saletnik	J. M. Williams
Directors	O. D. Anthony	J.W. Davidson	T.E. Kuhn	B. T. Burns
	J. T. Kapp	D.J. Lewis	D.R. Ladner	J. J. Horney
	D. J. Lewis	T.E. Kuhn	R.A. Tallent	W. J. Semioli
	J. W. Davidson	D.R. Ladner	B.T. Burns	R. E. Fronczak
	H. J. Laga	R.A. Tallent	J.J. Horney	W. P. Cunningham
	A. S. Uppal	B.T. Burns	W.J. Semioli	J. H. Smith
	T. E. Kuhn	J.J. Horney	D.W. Brookings	E. Bond
	D. R. Ladner	W.J. Semioli	W.P. Cunningham	D. L. Steele
	R. A. Tallent		J.H. Smith	M. C. Walbrun

	1986-1987	1987-1988	1988-1989	1989-1990
President	J. T. Kapp	D. J. Lewis	R. A. Tallent	B. T. Burns
Sr. Vice President	D. J. Lewis	R. A. Tallent	B. T. Burns	J. J. Horney
Jr. Vice President	R. A. Tallent	B. T. Burns	J. J. Horney	M. C. Walbrun
Jr. Vice President	B. T. Burns	J. J. Horney	M. C. Walbrun	P. H. Saletnik
Secretary	P. A. Weissmann	P. A. Weissmann	P. A. Weissmann	P. A. Weissmann
Treasurer	J. M. Williams	J. M. Williams	J. M. Williams	J. M. Williams
Directors	W. H. Nelson	M. C. Walbrun	C. E. Thompson	W. H. Nelson
	J. H. Smith	S. Lipkus	H. L. Davidson	T. J. Parker
	J. J. Horney	D. L. Steele	J. A. VanHuis	R. C. Karsten
	M. C. Walbrun	C. E. Thompson	W. H. Nelson	R. C. Carter
	E. Bond	H. L. Davidson	T. J. Parker	T. V. Dunn
	D. L. Steele	J. A. VanHuis	R. C. Karsten	M. L. Bradley
	C. E. Thompson	W. H. Nelson	S. Lipkus	D. G. DeBerg
	H. L. Davidson	T. J. Parker	T. V. Dunn	D. F. Sorgenfrei
	J. A. VanHuis	R. C. Karsten	M. L. Bradley	J. A. Lileikis

	1990-1991	1991-1992	1992-1993	1993-1994
President	J. J. Horney	M. C. Walbrun	P. H. Saletnik	D. L. Steele
Sr. Vice President	M. C. Walbrun	P. H. Saletnik	D. L. Steele	J. A. Van Huis
Jr. Vice President	P. H. Saletnik	D. L. Steele	J. A. Van Huis	M. L. Bradley
Jr. Vice President	W. H. Nelson	J. A. Van Huis	M. L. Bradley	J. A. Lileikis
Secretary	P. A. Weissmann	P. A. Weissmann	P. A. Weissmann	P. A. Weissmann
Treasurer	J. M. Williams	D. J. Lewis	D. J. Lewis	D. J. Lewis
Directors	R. C. Carter	D. G. DeBerg	D. L. McCammon	R. W. Carter
	T. V. Dunn	D. F. Sorgenfrei	J. T. Creighton	C. W. Young
	M. L. Bradley	J. A. Lileikis	J. G. Bradley	D. K. Franz
	D. G. DeBerg	D. L. McCammon	R. W. Carter	J. L. Hostler
	D. F. Sorgenfrei	J. T. Creighton	C. W. Young	J. L. Neece
	J. A. Lileikis	J. G. Bradley	D. K. Franz	R. W. Kaye
	D. L. McCammon	R. W. Carter	J. L. Hostler	M. L. Johnson
	J. T. Creighton	C. W. Young	J. L. Neece	T. Rich
	J. G. Bradley	D. K. Franz	R. W. Kaye	D. E. Bartholomew

	1994-1995	1995-1996
President	J. A. Van Huis	M. L. Bradley
Sr. Vice President	M. L. Bradley	J. A. Lileikis
Jr. Vice President	J. A. Lileikis	R. W. Carter
Jr. Vice President	R. W. Carter	D. K. Franz
Administrative Director	P. A. Weissmann	P. A. Weissmann
Treasurer	D. J. Lewis	D. J. Lewis
Directors	J. L. Hostler	M. L. Johnson
	J. L. Neece	T. Rich
	R. W. Kaye	D. E. Bartholomew
	M. L. Johnson	P. L. Barrett
	T. Rich	D. W. Cook
	D. E. Bartholomew	R. C. Dummar
	P. L. Barrett	R. L. Calhoun
	D. W. Cook	W. Benton III
	R. C. Dummar	W. G. Gemeiner

CONSTITUTION

(Revised September 18, 1990)

ARTICLE I

NAME

Section 1. This Association shall be known as the American Railway Bridge and Building Association.

ARTICLE II

OBJECT

Section 1. The object of this Association shall be the advancement of knowledge pertaining to the design, construction and maintenance of railway structures and fixed facilities by investigation, reports and discussions.

Section 2. The Association shall neither endorse nor recommend any particular devices, trademarks or materials, nor will it be responsible for any opinions expressed in papers, reports or discussion unless the same have received the endorsement of the Association in regular session.

ARTICLE III

MEMBERSHIP

Section 1. The membership of this Association shall be divided into five classes: Members, Life members, Associate members, Honorary members and Junior members.

Section 2. A member shall be a person in the railway industry (except representatives of manufacturers and/or suppliers of equipment, material or labor services) engaged in engineering, construction and maintenance of railway structures and fixed facilities; a person in the employ of a public regulatory body; a professor of engineering or architecture; a technical editor; a materials expert; a consulting engineer, or an engineer employed by a consulting engineering firm, engaged in the engineering, construction and maintenance of railway-related facilities; an engineer employed by a technical service or research and development organization; or an officer or engineer of an engineering or scientific society or association whose aims and objectives are compatible with the aims and objectives of this Association. Any person desirous of becoming a member shall make application upon the form prescribed by the Executive Committee, setting forth the applicant's name, address and practical experience. The applicant shall be recommended by at least one member of the Association to whom they are personally known. Applicants may be voted into membership at any regular executive meeting or by letter ballot of the Executive Committee, a majority vote being necessary in either instance.

Section 3. To be eligible for a life membership, an individual must have belonged to the Association for at least 15 years and in general must have retired from active employment due to age or physical disability. A life member shall have all the privileges of previous membership, except the holding of office, and shall not be required to pay annual dues. The transfer from membership to life membership shall be made in the same manner as the election of members, as prescribed in Section 2 of this Article.

Section 4. Associate members shall be responsible persons who are not eligible as members, whose pursuits or attainments qualify them to cooperate with members in the study and development of improved practices in the construction and maintenance of railway structures and fixed facilities. They shall have all the rights of members except of voting and holding office. They shall be elected in the manner prescribed for members, in Section 2 of this Article, except that they shall be recommended by either a member or an associate member of the Association to whom they are personally known.

Section 5. Honorary members shall be chosen from persons who have attained acknowledged eminence in some branch of engineering or railway service. Their number shall be limited to ten. Honorary members shall be proposed by not less than six active members and shall be elected by the majority vote of the members present at a regular meeting. They shall have all the rights of members except that of holding office and shall be exempt from the payment of dues.

Section 6. Any person in the Association membership whose conduct in any way diminishes the professionalism or prestige of the Association, or who shall refuse to comply with the rules of this Association, shall forfeit membership in the Association on a two-thirds vote of the Executive Committee.

Section 7. Membership shall continue until written resignation is received by the secretary, unless member has been previously expelled, or dropped for non-payment of dues in accordance with Section 1 of Article VII.

Section 8. Only members shall hold office in this Association, and only members and qualified life members shall be entitled to vote in the election of officers.

Section 9. Junior members shall be persons engaged in academic study toward a career in those areas described in Section 2 of this Article, but not currently employed in those areas. They shall have all the rights of members except of voting and holding office. They shall be elected in the manner prescribed for members in Section 2 of this Article, except that they need not be recommended by a member of the Association. The term of junior membership shall be limited to five years.

ARTICLE IV

OFFICERS

Section 1. The officers of the Association shall be a president, a senior vice president, two junior vice presidents, a treasurer and nine directors, who, with the most recent past president, shall constitute the Executive Committee.

Section 2. The past presidents of this Association, previous to the most recent past president, who continue to be members shall be privileged to attend all meetings of the Executive Committee, of which meetings they shall receive due notice, and be permitted to discuss all questions and to aid said committee by their advice and counsel; but said past presidents shall not have a right to vote, unless called upon to fill a quorum.

Section 3. Vacancies in any office shall be filled for the unexpired term by the Executive Committee without delay.

ARTICLE V

EXECUTIVE COMMITTEE

Section 1. The Executive Committee shall manage the affairs of the Association and shall have full power to control and regulate all matters not otherwise provided for in the constitution and by-laws and shall exercise general supervision over the financial interests of the Association, and make all necessary purchases and contracts required to conduct the general business of the Association, but shall not have the power to render the Association liable for any debt beyond the amount then in the treasury plus accounts receivable and not subject to other prior liabilities. All appropriations for special purposes must be acted upon at a regular meeting of the Association.

Section 2. Meetings of the Executive Committee may be called by a majority of the members of the committee, providing ten days' notice is given to the executive committee by mail.

Section 3. Five members of the Executive Committee, one of which shall be either the president or a vice president, shall constitute a quorum for the transaction of business.

ARTICLE VI

ELECTION OF OFFICERS AND SECRETARY AND TENURE OF OFFICE

Section 1. Except as otherwise provided, the officers shall be elected at the regular annual meeting of the Association and the election shall not be postponed except by a two-thirds vote of the members present at said annual meeting. The election shall be by vote, a majority of the votes cast being required for election. Any member of the Association not in arrears for dues shall be eligible for office, but the president shall not be eligible for re-election.

Section 2. The president, two junior vice presidents, and treasurer shall hold office for one year and the directors for three years; three directors being elected each year. The senior vice president shall hold office for one year and ascend to the office of president at the expiration of such service. All officers shall retain their office until their successors are elected and installed. A director elected for a three-year term shall not be eligible to serve two consecutive terms.

Section 3. The term of office of the treasurer may be terminated at any time by two-thirds vote of Executive Committee. The compensation of the treasurer shall be fixed by a majority vote of the Executive Committee.

Section 4. The secretary shall be appointed by a majority vote of the Executive Committee and the term shall terminate with the appointment of successor. The Executive Committee shall have the power, by two-thirds vote, to remove the secretary and appoint a successor at any time. The salary of the secretary shall be decided by a majority vote of the Executive Committee.

Section 5. The secretary and the treasurer shall be required to give bond in an amount to be fixed by the Executive Committee.

ARTICLE VII

MEMBERSHIP FEE AND DUES

Section 1. Every member, upon joining this Association, shall pay to the secretary an entrance fee and dues as prescribed by the executive committee. No member in arrears for annual dues shall be entitled to vote at any election and any member more than one year in arrears may be stricken from the list of members at the discretion of the Executive Committee.

Section 2. A person stricken from the list of members because of non-payment of dues upon written application may be reinstated as a member in the former class of membership without loss of privileges, either upon payment of all back dues (which must accompany applications) or at the discretion of the Executive Committee voting in the manner prescribed in Section 2 of Article III.

ARTICLE VIII

LOCAL SECTIONS

Section 1. Upon the application of ten or more members of the Association residing in the same geographical district, or having offices therein, the Executive Committee shall organize a local section for that district, to which all members in that district shall be eligible. Such local section shall admit to active membership only members in good standing. It shall hold not less than two meetings each year, and shall be governed by such constitution and by-laws not inconsistent with the constitution of this Association as the section membership may adopt and the Executive Committee approve.

Section 2. The parent Association shall not be put under any obligation, either financial or in the matter of policy or opinion, by any local section.

ARTICLE IX

AMENDMENTS

Section 1. This constitution may be amended at any regular meeting by a two-thirds vote of the members present, provided that notice of the proposed amendment or amendments has been sent to the members at least 30 days previous to said regular meeting.

By-Laws

(Revised July 11, 1994)

Time of Meeting

1. The regular meeting of this Association shall convene annually during the month of September, the exact date to be fixed by the Executive Committee.

2. It shall be within the power of the Executive Committee to change the time of the meeting if it becomes apparent that it is for the best interests of the Association.

Place of Meeting

3. The place of holding the annual meeting shall be determined by the Executive Committee not less than twelve months prior to the date of the annual meeting.

Quorum

4. At the regular meeting of the Association, 15 or more members shall constitute a quorum.

Dues

5. The annual dues for the fiscal year ending August 31, and payable in advance, shall be as follows:

Members, $25.00; Associate Members, $25.00; Junior Members, $25.00

Duties of Officers

6. The president shall have general supervision over the affairs of the Association. He shall preside at all meetings of the Association and of the Executive Committee; shall appoint all committees not otherwise provided for, and shall be ex-officio member of all committees. The president (or appointed Executive Committee member) shall render a detailed report at least three times during the year to the members of the Executive Committee, showing the financial condition of the Association and its activities.

At the annual meeting the president (or appointed Executive Committee member) shall present a report containing a statement of the general condition of the Association.

7. The vice presidents, in order of seniority, shall preside at meetings in the absence of the president and discharge the duties of the president in case of a vacancy in his office. The senior vice president shall have the senior position of vice presidents.

8. The secretary shall keep a correct record of the proceedings of all meetings of this Association, and of all accounts, between this Association and its members, collect all moneys due the Association, and deposit the same in the name of the Association. The secretary shall pay all bills when properly certified and approved by the president or the treasurer, and make such reports as may be called for by the Executive Committee. The secretary shall sign all contracts or other written obligations of the Association which have been approved by the Executive Committee. The secretary shall also perform such other duties as the Association may require.

9. The treasurer shall have charge of the funds, check all deposits as made by the secretary, and invest all funds not needed for current expenses. The treasurer shall report at each annual meeting on the condition of the finances.

Nominating Committee

10. After each annual meeting the president shall appoint a committee consisting of five members. The most immediate past president shall act as chairperson. No other officers of the Association shall be appointed to this committee. This committee shall prepare a list of names of nominees for officers to be voted on at the next annual meeting in accordance with Article VI of the Constitution, said list to be read at the business session of said meeting. Nothing in this section shall be construed to prevent any member making further nominations provided that such nominations are received by the president in writing not less than thirty (30) days in advance of the first day of the annual meeting. Such nominations should be addressed to the president of the Association at its headquarters office.

Auditing Committee

11. Prior to each annual meeting the president shall appoint a committee of three members, not officers of the Association, whose duty it shall be to examine the accounts and vouchers of the secretary and the treasurer and certify as to the correctness of their accounts.

Orders of Business

12. The order of business at the annual meeting of the Association shall be as follows:

- Call to order by president
- Opening prayer or invocation
- President's address
- Presentation of papers, reports and special presentations
- Reports of standing committees
- Business Session
  - Report of Secretary
  - Report of Treasurer
  - Report of Auditing Committee
  - Report of Nominating Committee
  - Election of Officers
  - Necrology Report
  - Unfinished business
  - New business
- Installation of officers
- Adjournment

The order of business may be modified by the Executive Committee prior to the meeting, and is subject to change by the chair, unless protested by a majority vote of members present.

Decisions

13. The votes of a majority of the members present shall decide any questions, motion or resolution which shall be brought before the Association, unless otherwise provided. Unless specifically provided herein otherwise, all discussions shall be governed by Robert's Rules of Order.

Amendments

14. The By-Laws can be amended by a two-thirds vote of those present at any regularly called Executive Committee Meeting.

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Anderson B R, Engr Of Trk, Conrail, 850 N Henderson Rd, King Of Prussia, PA, 19406 10-04-82
Anderson T P, Bridge Foreman, C&NW Trans Co, 310 6th Ave N, S St Paul, MN, 55075 04-06-93
Applegate D, Mgr Of Bridge Mtce, UP RR, 833 E 8th St, Stockton, CA, 95206 07-24-91
Arnold R C, Assoc Prof, U Of Nebraska At Omaha, Eng 125A, Omaha, NE, 68182 12-06-93

Bagwell M W, VP/GM, Mississippi Export RR, PO Box 8743, Moss Point, MS, 39562-8743 03-16-88
Bailey J, Supv B&B Dept, METRA, 14736 S Major, Oak Forest, IL, 60452 08-31-77
Baker R C, Engr Trk & Strs, EJ&E RY, 1141 Maple Rd, Joliet, IL, 60434 09-14-80
Barrett J E, President, Bowman, Barrett & Assocs, Inc., 130 E Randolph St #2650, Chicago, IL, 60601-6207 12-09-71
Barrett P L, Engr Const & Mtce, AT&SF RY, 4515 Kansas Ave, Kansas City, KS, 66106 02-17-82
Bartholomew D E, Sr Proj Mgr RR Facilities, Sverdrup Civil, Inc., PO Box 97062, Kirkland, WA, 98083-9762 09-15-86
Bateman J D, Mgr Bridge Mtce, UP RR, RR 3 Box 3332K, Elkhart, TX, 75839-9424 12-03-82
Beard E E, B&B Supv, IC RR, RR 1, Box 69B, Sigel, IL, 62462 07-24-91
Beck C, Supv B&B, NICTD, 601 N Roeske Ave, Michigan City, IN, 46360 01-06-93
Beebe L C, Mgr Sfty Srvcs, UP RR, 1416 Dodge St, Rm 800, Omaha, NE, 68179 12-04-85
Begg W B, Engr Of Strs, CC&P RR, 402 E Fourth St, Waterloo, IA, 50704 10-08-91
Begnaud R A, Engineer II, Amtrak, 2961 Hale St, Philadelphia, PA, 19149 05-08-84
Beirne J M, Mgr Trk Insp & Dvlpmnt, NS Corp, 110 Franklin Rd SE, Roanoke, VA, 24042-0077 08-20-76
Beitzel M J, Sr Engr Tech, Modjeski & Masters, 7129 Meadowbrook Dr, Mandeville, LA, 70471 09-22-91
Belkaloul E, Sr Bridge Engr, Transport Canada, 344 Slater St, Ottawa, ONT, CAN, K1A 0N5 09-16-90
Bennett C P, Asst Engr-Grd Sprtn Strs, NS Corp, 99 Spring St SW, Atlanta, GA, 30303 01-09-90
Bennett D W, Asst B&B Supv, Montana Rail Link, Box 8779-101 Int'L Way, Missoula, MT, 59807 04-23-92
Bennett R M, Professor, U Of Tennessee, Department Of Civil Engr, Knoxville, TN, 37996-2010 07-11-94
Benton W, Engr. Structures, NS Corp, 99 Spring St SW, Atlanta, GA, 30303 08-17-88
Beran J R, Chf Engr, UP RR, 1416 Dodge St Rm 920, Omaha, NE, 68179 09-07-83
Bhalakia M P, Consultant, Engineering Srvcs, 8251 E Van Buren Dr, Pittsburgh, PA, 15237-4405 09-16-73
Bibly K C, Mgr Pwr Hse, Amtrak, 210 S Canal St, Chicago, IL, 60606 10-10-67
Biddy L D, Supv Bridges, CSX Transportation, 4100 Vanderbilt Rd, Birmingham, AL, 35217 03-22-95
Billings J D, Mgr Bridge Mtce, UP RR, 375 Beech St, Chadron, NE, 69337 10-03-74
Billingsley R E, Gen B&B Supv, NS Corp, 8 N Jefferson St, Roanoke, VA, 24042-0049 12-05-86
Bilson T E, Supv Of Strs Insp, Conrail, 53 Manchester Rd, Sewell, NJ, 08080 07-11-94
Birgenheier J A, Engr Strl Mtrls, BNSF, 777 Main St-1900 Cntntl Plz, Fort Worth, TX, 76102-2007 02-06-89
Bishop G L, Strl Dtlr, NS Corp, 99 Spring St, Atlanta, GA, 30303 09-20-87
Boileau R J, AVP-Constr, BNSF, 777 Main St-1900 Cntntl Plaza, Fort Worth, TX, 76102 03-27-85
Bonas D J, Asst Engr Strs, NS Corp, 99 Spring St SW, Atlanta, GA, 30303 11-02-83
Bond E, Chf Engr Br & Strs (Ret.), NS Corp, 2695 S Arbor Dr, Marietta, GA, 30066 09-28-66
Boraas R S, Bridge Engr-Dsgn, SP Lines, One Market Plaza-Room 1007, San Francisco, CA, 94105 10-02-86
Borden L V, Sr Associate, Modjeski & Masters, 4909 Louise Dr, Mechanicsburg, PA, 17055 02-05-91
Borg M T, Mgr B&B-Network Mgmnt, BN RR, 42052 Pearson Ranch Loop, Parker, CO, 80134-4457 02-24-84
Bothwell F J, Structures Supvr., CN North America, 197 York St., London, ONT, CAN, N6A 1B3 09-16-90
Bowman R L, Sr Metallurgical Engr, NS Corp, 110 Franklin Rd SE-Box 77, Roanoke, VA, 24042-0077 05-19-95
Bradley J G, Asst Div Engr-Bridges, NS Corp, PO Box 14820, Knoxville, TN, 37914 06-07-90
Bradley M L, Proj Engr, Conrail, 425 Holiday-Ste. 213, Pittsburgh, PA, 15220 08-31-82
Brantley B, Dsgn Engr, Alfred Benesch & Co, 205 N Michigan Ave-Blvd Twrs S, Chicago, IL, 60601 09-18-94
Brauer R J, Associate, The Sear-Brown Group, 85 Metro Park, Rochester, NY, 14623 03-22-95
Brewer T, Mgr Trng-Engineering, Wisconsin Central Ltd, PO Box 350, Van Dyne, WI, 54937 12-12-94
Briggs D R, Proj Engr, KCS RY, 4601 Blanchard Rd, Shreveport, LA, 71107 03-25-92
Brinck M J, Supv Of Strs, Conrail, 4427 Venus Ave, Harrisburg, PA, 17112-9128 02-05-91
Brookings D W, VP & Chf Engr, KCS RY, 114 W 11th St, Kansas City, MO, 64105 09-26-77
Brooks R L, Supv Strs, BNSF, 777 Main St #1400, Fort Worth, TX, 76102-5304 10-08-80
Broussard C T, AGM-Bus Dvlpmnt, LA & Delta RR, 402 W Washington St, New Iberia, LA, 70560 08-18-87
Bruestle K E, Sr Proj Mgr, HNTB, 1201 Walnut, Ste 700, Kansas City, MO, 64106 09-07-83
Buchanan R S, Vice President, Apex Contracting Inc, 1608 Jackstown Rd, Paris, KY, 40361 09-26-84
Buchko D E, Sr. Project Engr., CTE Engineers, 1308 Jill Terrace, Homewood, IL, 60430-4046 09-17-75
Buckles D M, Iron Worker-Strl Steel, C&NW Trans Co, 1420 Crawford St, Boone, IA, 50036 06-04-92
Burgel W D, Mgr, RY Engnr, BRW, Inc, 700 NE Multnomah St #1050, Portland, OR, 97232-4110 12-06-90
Burns B T, Structure Engr, AT&SF RY, 4515 Kansas Ave, Kansas City, KS, 66106 03-03-78
Burns M R, Supv-Equip & Facilities, So. Buffalo RY Co, 3556 Lake Shore Rd #300, Buffalo, NY, 14219-1400 04-06-93
Burrell J H, Bridge Insp, IC RR, 506 Carrollton Ave, Greenwood, MS, 38930-4508 02-15-96
Burrow J D, Gen Frmn, UP RR, 1000 W 4th St, Rm 16, N Little Rock, AR, 72114 04-08-94
Burrows F G, Consl Engr (Prof Of Engr), CA State U, 427 Bayside Rd, Apt B, Arcata, CA, 95521 10-10-73
Burshiem J D, Rdmstr, CP Rail System, 133 N Loop Rd, Savanna, IL, 61074 01-06-93
Busboom G G, Sr Dsgn Tech, ESCA Consultants Inc, PO Box 159, Urbana, IL, 61801 03-21-88
Busch K L, Associate, Homer & Shifrin Cnslt Engrs, 5200 Oakland Ave, St Louis, MO, 63110-1436 08-31-77
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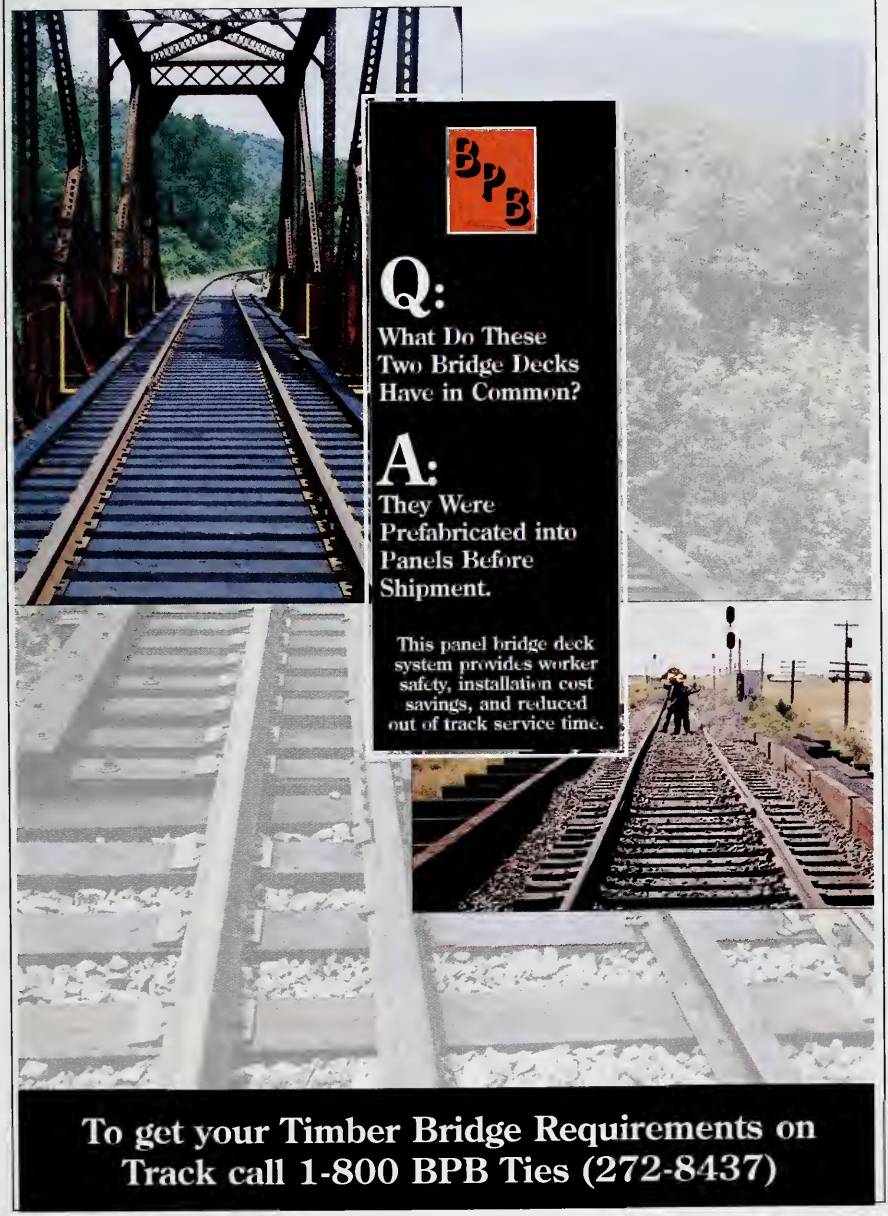
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Bynum F N, Bridge Insp, AT&SF RY, PO Box 1179, Lampasas, TX, 76550 07-11-94

Caley D L, Mgr Of Bridge Mtce, UP RR, 2645 New York Ave, Wichita, KS, 67219 07-24-91
Calhoun R L, Associate, CTE Engineers, 168 N Clinton St, Chicago, IL, 60661 09-18-88
Carapucci C U, Engr B&B, Conrail, 2193 Clover Dr, Broomall, PA, 19008 08-24-94
Carrato J L, Asst VP, Alfred Benesch & Co, 205 N Michigan Ave, Chicago, IL, 60601 09-30-88
Carter A B, Supv Of B&B, CSX Transportation, 1617 Seminole Springs Rd, Waycross, GA, 31501-4191 03-31-77
Carter J N, Asst Div Engr, NS Corp, PO Box 3070, Norfolk, VA, 23514 10-20-86
Carter R F, Engr Supv, UP RR, PO Box 95, Minersville, UT, 84752-0095 02-21-95
Carter R W, Coord Public Prgms, BN RR, 373 Inverness Dr South, Englewood, CO, 80112 03-27-85
Carver W, Supt M/W, Columbus & Greenville RY, PO Box 6000, Columbus, MS, 39703 02-10-93
Cary D J, B&B Supv, Boston & Maine Corp, RR 1, Box 254, East Deerfield, MA, 01342 12-05-91
Castrucci A, Sys Engr Strs-Fac, Conrail, 2001 Market St, 10-B-POB 41410, Philadelphia, PA, 19101-1410 05-04-82
Cerny L T, Engineering Dept, AAR, 50 F St NW Rm 7702, Washington, DC, 20001 03-26-80
Chapin S J, Br Dsgn Engr, Hays, Seay, Mattern & Mattern, Po Box 13446, Roanoke, VA, 24034 04-02-86
Charles H H, Engr Strs, Providence & Worcester RR, PO Box 16551, Worcester, MA, 01601 02-06-89
Charrow A M, Genl. Rdmstr, BNSF, 106 N First St, Belen, NM, 87002 10-04-82
Chiaramonte A C, Bridge Insp, AT&SF RY, 180 Marcy Ave, Raton, NM, 87740 03-22-95
Choros J, Prncpl Engr, CTL, 5420 Orchard Rd., Skokie, IL, 60077-1030 04-23-92
Cizek R R, Gen Frmn Strs-B&B, C&NW Trans Co, 430 Allonby, Schaumburg, IL, 60194 05-19-95
Clark J W, Engineer, 174 Marshall Bridge Dr, Greenville, SC, 29605-1247 03-31-87
Clark K L, Asst Strs Engr, AT&SF RY, 4515 Kansas Ave, Kansas City, KS, 66106 02-21-95
Clark M A, Dtlr-Str, NS Corp, 99 Spring St SW, Atlanta, GA, 30303 08-17-88
Clark T H, Engr.Bridges Dist.#6, CSX Transportation, 2715 Ranier St, Florence, SC, 29506 06-01-76
Clarke D B, Asst Dir Trans Cntr, U Of Tennessee, Knoxville, TN, 37996-4133 02-17-94
Clarke N, Bridge Inspector, CP Rail System, 120 Brookside Rd, Dalton, PA, 18414 04-23-92
Cline L J, Strs Supv, UP RR, 1416 Dodge St, Rm 1000, Omaha, NE, 68179 07-24-91
Coates D E, PUCO/RR Inspector, PUC Of Ohio, 33339 Myres Rd, Pomeroy, OH, 45769 07-24-91
Cohee M T, Bridge Insp, Conrail, 5406 Asherbrand Ln #A, Dublin, OH, 43017-5082 02-17-94
Comstock C F, Sr VP, Modjeski & Masters, PO 2345, Harrisburg, PA, 17105 12-03-87
Conroy R P, Mgr B&B, D&H RY, 320 Snake Hill Rd, Poestenkill, NY, 12140 07-24-91
Contreras J, Associate, Carter & Burgess, Inc, 7950 Elmbrook Dr, Dallas, TX, 75247 01-22-96
Cook D W, Supv B&B, Montana Rail Link, 201 International Way, Missoula, MT, 59807 02-05-91
Cooper L M, Strs Supv, UP RR, 1416 Doge St, Rm 1000, Omaha, NE, 68179 07-24-91
Corcoran R, Proj Engr, Amtrak, 210 S Canal St, Rm 410, Chicago, IL, 60606 06-01-89
Costantino A A, Engr Of Trk, Ll RR, Jamaica Station, Jamaica, NY, 11435 08-24-84
Costigan J M, Asst B&B Supv, CN North America, 197 York St, London, ONT, CAN, N6A 1B3 03-25-92
Covill C R, Asst Supv Strs, Conrail, 3520 Plumey Rd, Northwood, OH, 43619 12-03-87
Cox J, Staff Engr., Amtrak, 1285 Montecito Ave #14, Mountain View, CA, 94043 04-23-92
Coy K E, B&B Supv, CSX Transportation, 6609 E Walnut St, Evansville, IN, 47715 06-01-89
Cracchiolo A, Frmn B&B, TRRA Of St Louis, 700 N 2nd St, Rm 203, St Louis, MO, 63102 04-08-94
Craft J M, Bridge Engr, So CA Regional Rail Authority, PO Box 133, Big Bear City, CA, 92314 06-12-87
Craine A S, Engr B&B, Conrail, 2605 Interstate Dr, Rm 360, Harrisburg, PA, 17110 09-16-90
Creighton J T, Strs Supv, CP Rail System, PO Box 50, Revelstoke, BC, CAN, V0E 2S0 09-17-90
Criger L E, Mgr Civil Dept, Pritchard Corp, 10950 Grandview Dr, Overland Park, KS, 66210 10-22-87
Crisp F J, Sr Engr, Southern Co. Services, 2028 Lakemoor Dr, Birmingham, AL, 35244 02-17-94
Culbertson B R, Mgr Of Strs, C&NW Trans Co, 900 Story St, Boone, IA, 50036 09-20-87
Cummings J R, Mgr Trk & Strs, The Indiana RR Co, PO Box 2464, Indianapolis, IN, 46206-2464 02-21-95
Cunningham W P, Ops Engr, Missouri-American Water Co, 18 Great Lakes Dr, St Peters, MO, 63376-3226 08-12-81
Cyrus M A, B&B Supvr., Willamette & Pacific RR, 110 W 10th St, Albany, OR, 97321 07-29-93

Daniel T, B&B Supv, NS Corp, 800 Princeton Ave, Bluefield, WV, 24701 04-23-92
Darnell K E, Sr Vice President, Ogden Environmental, 1009 Commerce Park Dr #100, Oak Ridge, TN, 37830-8027 03-25-83
David W B, Midwest Reg Mgr, STV Inc., 70 W Madison St, Ste 2840, Chicago, IL, 60602-4207 03-18-87
Davids G A, Bridge Engr, FRA, 400—7th St SW (RRS-15), Washington, DC, 20590 03-22-73
Davidson H L, Reg Mgr Of Gangs, CSX Transportation, PO Box 1500 Lynn Avenue, Corbin, KY, 40701 08-14-86
Davis D A, B&B Frmn, CP Rail System, E 9102 Oak Leaf Ln, Wisconsin Dells, WI, 53965 07-11-94
Davis D R, Genl Supt, The Bay Line Rwy, PO Box 35098, Panama City, FL, 32412-5098 05-16-73
Davis M, Engr B&B, Boston & Maine Corp, 8 Graniteway, Somersworth, NH, 03878 03-21-93
Davis R R, B&B Supv, CP Rail System, 232 E Irving Park Rd, Wood Dale, IL, 60191 02-17-82
DeBerg D G, Chf Engr, DM&E RR, 818 Candlewood Ln, Brookings, SD, 57006 10-04-82
Decker D L, Strs Frmn, C&NW Trans Co, 6612 Clinton Ave, Richfield, MN, 55423 03-22-95
Deis F P, Instr-Cvl Tech, Northern ALB Inst. Of Tech., 11 Mill Dr, St Albert, ALB, CAN, T8N1J5 08-11-92
Del Signore P L, Engr B&B, Conrail, 1631 Augusta Dr, Pittsburgh, PA, 15237 06-07-90
Del Vecchio S, Engr.Strut.Oprns, CN North America, 277 Front St. W., Toronto, ONT, CAN, M5V 2X7 06-01-89
Delwo D C, Trng Supv, CN North America, 4629 Scott Ave, Terrace, BC, CAN, V8G 2B1 07-29-93
Dennis W B, B&B Supv, Iowa Interstate RR, 1007 W Main, Anita, IA, 50020 12-14-84
Derner A L, Railway Engineer, JBM Engineers & Planners Inc, 500 W 7th St #600, Fort Worth, TX, 76102-4700 12-12-88
Deterding D L, Dir Construction-West, UP RR, 1416 Dodge St-Room 1010, Omaha, NE, 68179 08-28-85
Dickerson R D, Bldg Mtce Engr, NS Corp, 99 Spring St, Atlanta, GA, 30303 09-20-87
Dobranetski E B, Chf-Major Invest. Branch, Natl Trans Sfty Bd, 18913 Cross Country Ln, Gaithersburg, MD, 20879 03-18-70
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Doty D A, Design Engineer, Modjeski & Masters, 1055 St Charles Ave-Rm 510, New Orleans, LA, 70047 10-21-92
Douglas D A, Mgr B&B, BN RR, 51 Broadway St N, Ste 201, Fargo, ND, 58102 09-20-87
Dout K R, Strl Supv, AT&SF RY, 11300 Burgan NE, Albuquerque, NM, 87111 10-04-82
Driscoll D J, Mgr B&B, BN RR, 5324 Trent, Spokane, WA, 99212 09-18-78
Dummar R C, Mgr Arch Dsgn, UP RR, 1416 Dodge St-Rm 1000, Omaha, NE, 68179 10-21-92
Duncan D R, Bridge Insp, IC RR, PO Box 111, Goreville, IL, 62939 08-20-91
Dunn H A, B&B Supv, IC RR, 506 Carrollton Ave, Greenwood, MS, 38903 03-16-88
Dunn R H, President, R H Dunn & Associates Inc, 123 Yorkshire Dr, Williamsburg, VA, 23185-3984 09-11-68
Dunn T V, 603 S Elm, Palatine, IL, 60067 02-17-82
Dunsworth J E, Mgr Bridge Const, UP RR, 2801 Rock Creek Pkwy, N Kansas City, MO, 64117 09-07-83
Dziak J E, Proj Mgr, IHB RR, 2721-161st St, Hammond, IN, 46323 09-17-80

Ebbers M F, Proj Engr, Dames & Moore, 6301 Indian School Rd NE, Albuquerque, NM, 87110-8113 03-28-90
Edwards G, Mtce Engr Strs, UP RR, 406 W First South, Salt Lake City, UT, 84101 12-19-75
Eich K W, Mgr Bridge Mtce, UP RR, 4823 N 119th St, Milwaukee, WI, 53225 07-19-89
Eldridge J E, Mgr Bridge Mtce, UP RR, 2801 Rock Creek Pkwy, N Kansas City, MO, 64117 09-08-86
Eppehimer R J, Associate, Modjeski & Masters, 1055 St Charles Ave, New Orleans, LA, 70130 08-10-90
Ernst K, Mtce Supvr, EJ&E RY, 1141 Maple Rd, Joliet, IL, 60432 06-06-91
Estes C A, Steel Br Frmn, AT&SF RY, 5230 N Broadway, Wichita, KS, 67219 04-26-88
Etienne F, Proj Engr, C&NW Trans Co, 165 N Canal St, Chicago, IL, 60606 03-25-92
Evans J E, Brs & Strs Cnstr Supv, CP Rail System, 26 Sunvale Mews SE, Calgary, ALB, CAN, T2X 3P5 10-11-94

Farnesi R E, Asst B&B Supv, METRA, 8416 S 77th Ave, Bridgeview, IL, 60455 12-06-93
Fatula P, Chf Exec, Rail Road Progress, PO Box 233, Gibbsboro, NJ, 08026 09-17-80
Ferguson E O, B&B Supv, BN RR, 106 Elm Ave, Castle Rock, CO, 80104 03-22-95
Findlay A G, B&B Master, CP Rail System, 233 Elgin St S, Sudbury, ONT, CAN, P3E 3N7 07-24-91
Fischer W L, Civil Engr, Science Applications Intl Corp, PO Box 121, West Paducah, KY, 42086 02-15-96
Ford P V, Structural Engr, Duffield Associates Inc, 2613 Lamper Lane, Wilmington, DE, 19808 09-16-81
Foth D D, Exec Director, American Public Transit Assn, 1201 New York Ave NW, Washington, DC, 20005 02-11-86
Fraise J D, Gen Supv Strs, AT&SF RY, 5800 N Main St, Fort Worth, TX, 76179 09-26-77
Franz D K, Bridge Engr, KCS RY, 114 W 11th St, Kansas City, MO, 64105 07-19-89
Freeman A G, Asst To Chf Engr, LS&I RR, 105 E Washington St, Marquette, MI, 49855 02-21-95
Freeman M P, Associate, Modjeski & Masters, 1304 Lake Louise Dr, Gretna, LA, 70056-8343 12-06-90
Frohberg E K, Dsgn Engr, BNSF, 777 Main St-1900 Cntntl Plaza, Fort Worth, TX, 76102-5384 08-24-94
Frost J S, Sr Br & Strs Engr (Ret), BC Rail, RR 1-Site N-Box 10, Bowen Island, BC, CAN, V0N 1G0 10-07-82
Futrell J E, Civil Engr, Design Nine, 9700 MacKenzie #204, St Louis, MO, 63123 04-03-95

Gall W, Sys Stl Br Insp, Conrail, 8079 Columbus Rd, Mount Vernon, OH, 43050-9358 01-05-89
Gallagher J, B&B Frmn, CP Rail System, 829 S Wacouta, Prairie Du Chien, WI, 53821 02-21-95
Galloway T M, Dir Bridge Mtce, CSX Transportation, PO Box 45052, Jacksonville, FL, 32232-5052 03-20-91
Galvin J M, Constr Engr, NJTRO, 51 Harman Rd, Edison, NJ, 08837 04-27-87
Garrett D, Rdmstr, Eastern AL RY, 1380 Reynolds Mill Rd, Alpine, AL, 35014 03-21-93
Gaspartich M, Prncpl Proj Engr, NJTRO, 1170 Aster Dr, Toms River, NJ, 08753 05-19-95
Gemeiner W G, Mgr Methods/Research, UP RR, 1416 Dodge St-MC 3300, Omaha, NE, 68179 04-06-93
Gerhardstein C A, Engr B&B, CSX Transportation, 8731 Rolling Brook Ln, Jacksonville, FL, 32256-9026 02-09-90
Gibbs R R, Supv Strs, AT&SF RY, 4515 Kansas Ave, Kansas City, KS, 66106 05-04-78
Gilbert T M, Bridge Insp, Conrail, 11420 Woodtown Rd, Galena, OH, 43021 08-29-89
Glavin W E, VP Equip Mgmnt, BN RR, 777 Main St-Suite 1700, Fort Worth, TX, 76102 09-19-88
Glidden M, Project Mgr., Merrick & Co., PO Box 22026, Denver, CO, 80222 03-20-91
Goble G G, Principal, Goble Rausche Likins & Assocs., 5398 Manhattan Crcl, Ste 100, Boulder, CO, 80303 02-17-94
Godinez F T, Trk Plng Engr, UP RR, 1416 Dodge St-MC3300, Omaha, NE, 68179 03-20-91
Goebel J, B&B Supv, CP Rail System, 913 Bowen St, Savanna, IL, 61074 02-11-92
Goewey C T, Engr Strs, NS Corp, 99 Spring St SW, Atlanta, GA, 30303 08-24-84
Goldberg D, Chf Engr, Goodkind & O'Dea Inc, 60 Feronia Way, PO Box 1708, Rutherford, NJ, 07070-0708 12-06-74
Goodall S A, Gen Dir Fld Ops, AT&SF RY, 4515 Kansas Ave, Kansas City, KS, 66106 01-05-89
Gosney D M, Supv Strs, AT&SF RY, 200 N Avenue H, Barstow, CA, 92311 09-26-84
Gould G C, Steel Crew Frmn, Union Pacific RR, 916 S Wenonah, Oak Park, IL, 60304-1811 02-10-93
Graves V T, Crane Operator, AT&SF RY, RR 2 Box 147, Marceline, MO, 64658-9802 02-21-95
Green H W, Sr. RR Engr., Santina & Thompson, 1355 Willow Way, Su.280, Concord, CA, 94520 11-05-82
Griffin D C, Dir Strl Dsgn, UP RR, 1416 Dodge St-Rm 1000, Omaha, NE, 68179 10-22-87
Griffin L B, B&B Supv, BC Rail, Box 8770, Vancouver, BC, CAN, V6B 4X6 02-23-81
Grotz W A, RR Proj Spec, FRA, 12245 Pointer Hill Ct, Ellicott City, MD, 21043 09-23-84
Groves G R, Mtce Engr Strs, UP RR, 2801 Rock Creek Pkwy, N Kansas City, MO, 64117 10-05-71
Gruebele C C, Mgr M/W, Red River Valley & Western RR, 501 Minnesota Ave, Breckenridge, MN, 56520 09-18-94
Gupta S N, Asst Chf Engr, Metro North Commuter RR, 347 Madison Ave-4th Flr, New York, NY, 10017 09-16-90

Haff G A, Sr Engr, NJTRO, 1139 Dove St., Toms River, NJ, 08753 03-23-94
Hager W J, Supvr Br & Str Const, CP Rail System, 6002—130th St W, Apple Valley, MN, 55124 03-21-93
Hague C H, Alfred Benesch & Co, 205 N Michigan Ave, Chicago, IL, 60601 05-15-74
Hague S T, Bridge Engr, HNTB, 5236 McCoy, Shawnee, KS, 66226 02-17-94
Hall F T, Proj Engr-Trk & Fac, Amtrak, 210 S Canal St-Rm 400, Chicago, IL, 60606 06-04-92
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Hand J M, Mgr Bridge Mtce, UP RR, 2730 SE Market St, Des Moines, IA, 50317 04-06-93
Hankinson E, Proj Engr, HDR Engineering, 1283 Cabrillo Park, Santa Ana, CA, 92701 03-23-94
Hanquist S W, Dir Constr-Southern, UP RR, 1416 Dodge St, Rm 1010, Omaha, NE, 68179 02-17-94
Harrington S J, Engr Tech II, UP RR, 201 E 17th St, Cheyenne, WY, 82001 04-03-95
Harris R, Supv B&B, BN RR, 373 Inverness Dr S, Englewood, CO, 80112 03-15-89
Haug G E, Mgr Engr, BN RR, 999—3rd Ave, Suite 2000 FIC, Seattle, WA, 98104 09-14-83
Hauschildt K G, Asst Engr Br Dept, NS Corp, 99 Spring St SW, Atlanta, GA, 30303 08-13-85
Hazell A, Asst To Exec VP, AAR, 50 F St NW, Washington, DC, 20001 07-11-94
Hedberg T W, Proj Mgr-RR Engr, TKDA, 444 Cedar St #1500, St Paul, MN, 55101-2110 06-04-92
Hedden W H, Engr Supv, UP RR, PO Box 815, Quincy, CA, 95971 02-21-95
Heinrich T C, Engr Strs, NS Corp, 99 Spring St SW, Atlanta, GA, 30303 06-14-85
Helgeson B, Asst Frmn, C&NW Trans Co, N7919—535th St, Spring Valley, WI, 54767-7807 03-22-95
Helm J M, Sr RR Engr-RR Struct., HDR Engineering, 6325 N. Avondale Ste. 110, Chicago, IL, 60631 09-17-72
Hendrickson L D, Mgr Str Plng, BN RR, 777 Main St-1900 Cntntl Plaza, Fort Worth, TX, 76102 03-28-84
Hensel R J, VP Of Engrng, NYS&W RY, 1 Railroad Ave C, Cooperstown, NY, 13326 06-04-92
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Hergenrader R M, AVP-Bus/Rail Facilities, DART, PO Box 660163, Dallas, TX, 75266-7257 04-23-92
Hernandez N D, Asst Supv Strs, Conrail, 3143 Lantern Dr, Oregon, OH, 43616 09-20-87
Herren G H, Supv Strs (Ret), AT&SF RY, 10218 Sagegreen Dr, Houston, TX, 77089 09-12-76
Hester G L, Mgr Bridge Mtce, UP RR, 16666 Fallen Tree Dr, San Antonio, TX, 78247-2028 10-02-86
Higgins N J, Sr Trk Engr, LS Transit Systems, 1515 Broad St, Bloomfield, NJ, 07003-3069 11-30-89
Hill G L, Mgr Br Constr, UP RR, 1416 Dodge St, BBMC 3300, Omaha, NE, 68179-0033 08-26-86
Hill S J, Mgr Br & Str Constr, CP Rail System, PO Box 530, Minneapolis, MN, 55440 12-03-92
Hille M A, Asst Div Engr-Bridges, NS Corp, 115 Rebel Dr, Somerset, KY, 42501 09-14-83
Hoadley D E, Clrnc Engr, CP Rail System, PO Box 8002, Clifton Park, NY, 12065-8002 02-20-74
Hool D K, Proj Engr, Conrail, 1318 Joanna Ct, Plainfield, IN, 46168 11-03-81
Horney J J, Sr Rail Mgr-Strs, Carter & Burgess, Inc, 4646 So. 132nd Street, Omaha, NE, 68137 10-15-79
Hostler J L, Str Engr, AT&SF RY, 106 N. First St, Belen, NM, 87002 12-12-88
Howard E, Asst Div Mgr-Engr, CP Rail System, 8001 Florida Ave N, Brooklyn Park, MN, 55445 03-23-94
Howell J E, Clrnc Engr, NS Corp, 99 Spring St, Box 142, Atlanta, GA, 30303 08-25-88
Hrncir S A, Proj Mgr, HNTB, 515 W Greens Rd Ste. 1100, Houston, TX, 77041 05-19-95
Hubbard J H, Rdmstr, Pittsburgh & Shawmut RR, RD 8, Box 45, Kittanning, PA, 16201 03-16-88
Hudak T M, Asst Mgr Engr, BN RR, 2000 FIC, 999—3rd Ave, Seattle, WA, 98104 09-20-92
Hughes K, Bridge Proj Engr, Alaska RR, PO Box 107500, Anchorage, AK, 99510-7500 02-10-93
Hunt L R, Field Engr, UP RR, 24125 Aldine-Westfield, Spring, TX, 77373 05-26-93
Hunter T W, Proj Engr Trk/Facilities, Amtrak, 210 S Canal St #410, Chicago, IL, 60606 04-26-91
Hutton H R, Sr Str Dsgnr, UP RR, 1416 Dodge St-Rm 1000, Omaha, NE, 68179 09-20-92
Huya T, Constr Engr, AT&SF RY, 520 Santa Fe St, Woodward, OK, 73801 03-22-95
Hynes T E, Local Grade Crsng Engr, Michigan DOT, 1199 Arbor Dr #12, East Lansing, MI, 48823 11-01-89

Iwinski J R, Structural Engr, 10107 Alden Rd, Harvard, IL, 60033 12-14-65

Jackson J P, B&B Insp, SLSW RY, 7010 E 30th, Hutchinson, KS, 67502 09-20-87
Jacobson L, Exec VP, Copper Basin RY, 9790 N Buena Vista, Oro Valley, AZ, 85704 08-24-94
Jamison B J, Tech Instr, NS Corp, 101 Thoroughbred Drive, McDonough, GA, 30253 07-12-93
Jennison K H, Asst. Dir. Br. Dsgn., BN RR, 777 Main St-1700 Cntntl Plaza, Fort Worth, TX, 76102-5834 12-05-88
Jensen A H, Mgr Envrmmntl Mtce, UP RR, 406 W First St South, Salt Lake City, UT, 84101 08-10-83
Jensen B D, Cntrct Engr-Public Projs, UP RR, 1416 Dodge St-Rm 1000, Omaha, NE, 68179 09-21-87
Jeske T, Mgr Trk & Strs, Twin Cities & Western RR, 2925—12th St E, Glencoe, MN, 55336 09-05-95
Jessen J M, Mgr Bridge Mtce-West, UP RR, Rt 5, Box 5158, Hermiston, OR, 97838-9704 07-24-91
Johanningmeier C, RR Engr, Columbia Terminal RR, PO Box N, Columbia, MO, 65205 09-19-93
Johnson A R, Chf Engr, C&IM RR, PO Box 139, Springfield, IL, 62705 06-01-76
Johnson D A, Architect, TKDA, 444 Cedar St #1500, St Paul, MN, 55101 02-21-95
Johnson G D, Engr Supv, UP RR, 588 Harmon Way, Middleton, ID, 83644-3063 02-21-95
Johnson J, Mgr Strs Dsgn, BNSF, 777 Main St-1900 Cntntl Plaza, Fort Worth, TX, 76102-5384 01-05-89
Johnson J M, Dir Of Engineering, Amtrak, 810 N Alameda St, Los Angeles, CA, 90012-2986 10-04-82
Johnson M L, Mgr Strs, BN RR, 3253 E Chestnut Expwy, Springfield, MO, 65803 02-24-84
Johnston G H, Supv Strs, Conrail, 1840 Parkwest Dr #103, Monroe, MI, 48161-9694 03-20-91

Kadota R M, Dir-Bridge Engnrng, BN RR, 777 Main St, Fort Worth, TX, 76102 04-03-95
Kann H S, Supv Strs, Conrail, RD 1, Box 958, Altoona, PA, 16601 06-06-91
Kapp J T, Sys Engr-Dsgn & Constr, Conrail, POB 41412-2001 Market St 12-B, Philadelphia, PA, 19101-1412 11-13-79
Kappler J, Mgr Qlty Cntrl, BN RR, PO Box 906, Columbus, MS, 39701 12-06-93
Karasay T, Area Constr Engr, Amtrak, 255 Welton St, Rear, Hamden, CT, 06517 02-17-94
Karsten R C, B&B Supv, SP Lines, 200 Marion Way, Bloomington, CA, 92316 08-25-78
Katcher G W, B&S Ops Officer, CN North America, 433 Main St, Winnipeg, MAN, CAN, R3C 2P8 03-24-82
Kaye R, Bridge Engr, IC RR, 1053 West Park Front, Joliet, IL, 60436 11-01-89
Kazmierczak J R, B&B Supv, NS Corp, 3605 Tazewell Pike, Knoxville, TN, 37918 04-26-91
Kelly R J, Civil Engr, Kelly Engr, Inc, 915—8th St, Boone, IA, 50036 01-22-96
Kenyon R S, Dir-Field Support, UP RR, 1416 Dodge St Room 800, Omaha, NE, 68179 12-06-85
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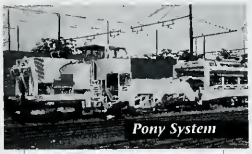

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Knuth G A, Mgr Strs, Wisconsin Central Ltd, 5910 Brown Rd, Little Suamico, WI, 54141 10-30-78
Knutson C C, Supv Strs, BNSF, 310 N Merrill, Glendive, MT, 59330 02-15-96
Koenig B L, Bridge Insp, Wisconsin Central Ltd, 257 Greeley, Berlin, WI, 54923 09-24-95
Krupa G E, Vice President, Clark Dietz, Inc., 216 S Jefferson, Suite 303, Chicago, IL, 60661 09-29-74
Kucirek E J, President, Kucirek Engineering, Inc, 4642 S 132nd St, Omaha, NE, 68137-1764 08-19-93
Kuczkowski M, Structures Supv, C&NW Trans Co, 701 Kress Rd, West Chicago, IL, 60185 04-21-89
Kuhn R C, Cnsltng Prof., Woodward Clyde Consultants, 101 S 108th Ave-1 Old Mill Bld, Omaha, NE, 68154 08-12-81
Kuhn T E, Principal, Design Nine, 9700 Mackenzie Rd, Ste 204, St Louis, MO, 63123 03-01-77
Kulick K L, Dir Sts Design, Amtrak, 30th Street Station 4S, Philadelphia, PA, 19104 10-08-80

Ladner D R, Engr Of Dsgn, Wisconsin Central Ltd, PO Box 5062, Rosemont, IL, 60017 03-01-77
LaHue S M, Steel Bridge Insp, AT&SF RY, 1624 First St NW, Albuquerque, NM, 87102-1538 09-13-89
Lake G D, Retired, 5675 W. Potter Dr., Glendale, AZ, 85308 11-05-82
Lamb R S, B&B Foreman, UP RR, 5701 W Vickery Blvd, Fort Worth, TX, 76107-7635 03-25-92
Lambert N W, 110 Jefferson St, La Grande, OR, 97850 07-24-91
Lamkin J R, Mgr Constr-South Reg, NS Corp, 1463 Seafoam Ct, Marietta, GA, 30066-1842 03-27-85
Lancaster J E, Chf Engr (Ret), St Lawrence & Atlantic RR, PO Box 377, Gray, ME, 04039-0377 10-26-73
Lane D R, B&B Master, CP Rail System, PO Box 8002, Clifton Park, NY, 12065 05-19-95
Langrehr I B, Steel Erector Frmn, CP Rail System, N4935 Oakview Dr #1, West Salem, WI, 54669 07-11-94
LaRose A E, Mgr Br Mtce, UP RR, 24125 Aldine Westfield, Spring, TX, 77373 09-14-83
Lasley D E, Consultant, 8601 S 68th E Ave, Tulsa, OK, 74133-4106 04-29-83
Lees H M, Dir Trk & Strs, BN RR, 777 Main St-Rm 2680, Fort Worth, TX, 76102-5384 12-09-71
Legare C G, Facility Supv Strs & Proj, CP Rail System, 2061 McCowan Rd-Ste 202, Scarborough, ONT, CAN 05-19-95
Leichner C H, Vice President, HDR Engineering, 8404 Indian Hills Dr, Omaha, NE, 68114 01-10-92
Lemanski F G, Str Sys Engr, NS Corp, 99 Spring St SW, Atlanta, GA, 30303 11-05-76
Lenning C R, Proj Mgr, HDR Engineering, 11020 King St, Ste 200, Overland Park, KS, 66210 03-22-95
Levy D, Vice President, Frederic R Harris, Inc, 222 W Sixth St, Ste 950, San Pedro, CA, 90731 07-18-90
Lewis D J, Asst Engr Of Strs, IC RR, 17641 S Ashland Ave, Homewood, IL, 60430-1345 09-19-73
Lewis G L, Sr Proj Mgr, CH2M Hill, 100 Inverness Terrace E., Englewood, CO, 80112 06-07-90
Lileikis J A, Sr Engr-Strs, Amtrak, 30th St. Station-4th Flr S, Philadelphia, PA, 19104 03-27-85
Linaberry W D, Asst DE-Strs, Conrail, 1 Buxton Ct, Barnegal, NJ, 08005 02-17-94
Lipkus S, Head-Bridge Mngmnt, Delcan Corp, 133 Wynford Dr, North York, ONT, CAN, M3C 1K1 06-04-82
Liston C L, 300 S Harrison, Pocatello, ID, 83024-3372 07-24-91
Lloyd S M, B&B Supv, NS Corp, 5100 Woodall Rd, Lynchburg, VA, 24502 08-17-88
Lott D W, Mgr Of Strs, C&NW Trans Co, 708 Lancaster Ln, Geneva, IL, 60134-3443 09-15-86
Lozano D E, Structure Engr, AT&SF RY, PO Box 395, Lake Arrowhead, CA, 92352 03-07-79
Luciano P L, Strl Engr, METRA, 547 W Jackson Blvd, Chicago, IL, 60661 07-24-95
Lusney J, B&B Supv., BC Rail, PO Box 8770, Vancouver, BC, CAN, V7V 3W7 10-05-90
Luzier W B, Chf Engr, LZR Engineering, Inc, 646 Exchange Pl.Su.125, Lilburn, GA, 30247 10-17-85
Lynn M R, Proj Engr, Amtrak, 600 Dey St, Niles, MI, 49120 11-16-95

Mader C E, Mgr RR Div, Wilson & Co, 3101 Broadway, Ste 310, Kansas City, MO, 64111 12-12-88
Maloney D, B&B Supv, EJ&E RY, One North Buchanan, Gary, IN, 46402 06-06-91
Mancuso J S, Regional Bridge Supvr., SP Lines, 9499 Atkinson St, Roseville, CA, 95678 02-10-93
Mangold T F, Gen Frmn, SEPTA, 945 Foss Ave, Drexel Hill, PA, 19026 07-12-93
Marianos W N, Associate, Modjeski & Masters, 6100 Center Grove, Ste. 2, Edwardsville, IL, 62025 08-10-90
Marks C K, Vice President, Green & Marks, 1977 Western Ave, Albany, NY, 12203 04-23-92
Marlow M J, Sr Proj Engr, Alfred Benesch & Co, Blvd Towers S-205 N Michigan, Chicago, IL, 60601 03-28-72
Martin B T, Sr Associate, Modjeski & Masters, 229 Manchester Rd #102, Poughkeepsie, NY, 12603-2534 04-26-88
Martinez F A, Engineer, HNTB, 13316 Veronica Rd, Farmers Branch, TX, 75234 02-17-94
Masters J R, Dir-Freight RR Engr Srvcs, HNTB, 1201 Walnut, Kansas City, MO, 64106 02-15-96
Maupin A J, Technologist, Alfred Benesch & Co, 1107 S 2nd St, St Charles, IL, 60174-4106 09-16-81
May J C, Proj Mgr-PA Clrnc Proj, Conrail, 2001 Market Street, Philadelphia, PA, 19101-1411 08-10-90
Maylie B J, Supv Of Strs, Conrail, 2912 Larkspur Ln, Secane, PA, 19018 07-11-94
McCammon D L, Office Engr, HNTB, 3609 S Wadsworth St #220, Denver, CO, 80235-2103 08-24-84
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McDonald G W, Sr RR Cnsltnt, 6418 S 120th Plz, Omaha, NE, 68137 12-06-90
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McGill J A, Bridge Supv, NS Corp, 308 Newman St, Hattiesburg, MS, 39401 08-25-70
McGinley M E, Dir Of Engrg, So CA Regional Rail Authority, PO Box 86425, Los Angeles, CA, 90086 05-08-84
McIntire G C, Asst Engr Strs, NS Corp, 99 Spring St SW, Atlanta, GA, 30303 03-20-91
McKenery D F, Tec II Operator, South Branch Valley RR, PO Box 470, Moorefield, WV, 26836 07-11-94
McLaughlin S J, VP-Engineering Srvcs, UP RR, 1416 Dodge St #1200, Omaha, NE, 68179 04-26-88
McManus R G, Asst VP Engr & Trk, AL&M, F&P And GLSR RRs, PO Box 757, Crossett, AR, 71635 04-06-93
McMaster M C, Const Engr, Conrail, 7405 Hillsboro, Canton, MI, 48187 09-17-78
McMurray T C, Sys Chf Engr, BN RR, 777 Main St-16th Flr, Fort Worth, TX, 76102 12-12-88
McNaughton S, Mgr Envrmntl Fld Ops, UP RR, 1416 Dodge St-Rm 930, Omaha, NE, 68179 11-18-94
McNeely L C, Supv Strs, AT&SF RY, PO Box 96362, Oklahoma City, OK, 73143 01-05-89
McNulty A, Asst Mgr M/W Trng, BN RR, 12345 College Blvd-ITC Bldg, Overland Park, KS, 66223 06-04-92
McQuitty J M, Strs Supv, C&NW Trans Co, 206 Eaton St, St Paul, MN, 55107 09-19-88
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Meyers G E, Mgr Of Strl Plng & Scdlng, UP RR, 1416 Dodge St-MC3300, Omaha, NE, 68179 03-20-91
Michael R G, Sr RR Assoc. (Ret), Bowman, Barrett & Assocs, Inc., 508 W 56th St, Hinsdale, IL, 60521-5101 02-19-85
Michaels R J, Strl Plng Engr, UP RR, 1416 Dodge St-Rm 1000-MC3300, Omaha, NE, 68179 03-20-91
Michel J N, Sr Rail Cnsltnt/Asst VP, LS Transit Systems, PO Box 447, Narberth, PA, 19072 06-08-79
Millsap S A, Asst Chf Engr-Strs, BN RR, 777 Main St-1900 Cntntl Plaza, Fort Worth, TX, 76102-5384 09-23-84
Misiaszek A E, Program Mgr, Amtrak, 6 Lantern Lane, Old Lyme, CT, 06371 02-17-94
Montgomery V T, Cvl Dsgn Engr, TKDA, 444 Cedar St #1500, St Paul, MN, 55101-2110 06-04-92
Moore A D, Mgr Strs Dsgn, BNSF, 805 Cliffmoor Dr., Keller, TX, 76248 02-06-89
Moore C B, Engr Supv, UP RR, 1412 Brentwood Dr, Fort Collins, CO, 80521-4300 02-21-95
Moroney B E, Asst Rdmstr, CSX Transportation, 34 Worcester Lane, Waltham, MA, 02154 04-23-92
Mortensen L P, Instr-Wldng Tech, Central Community College, 1123 Country Club Dr, Hastings, NE, 68901 08-11-92
Morton D M, Ast Ch Engr, TRRA Of St Louis, 700 N Second St, Rm 203, St Louis, MO, 63102 10-02-86
Mouton M, Trk Supv, LA & Delta RR, 402 W Washington St, New Iberia, LA, 70560 04-21-89
Murlatt G L, Supv. Strs., Conrail, 647 Observatory Dr, Lewisberry, PA, 17339 04-26-91
Murphy R C, Mgr. Strucures Design, BN RR, 777 Main St.1700 Contl.Plaza, Fort Worth, TX, 76102-5384 03-15-89
Murphy R F, Gen Frmn, UP RR, 2730 SE Market St, Des Moines, IA, 50317 10-08-91
Muth F R, Prncpl Engr, Muth Consulting Engineers, 913 SW Higgins Ave, Missoula, MT, 59803 07-24-91
Myres J H, Mgr Of Bridge Mtce, UP RR, 5701 W Vickery Blvd, Fort Worth, TX, 76107-7635 07-24-91

Naasz H E, Mgr Of Bridge Mtce, UP RR, 24125 Aldine-Westfield Rd, Spring, TX, 77373 07-24-91
Nagel R W, Engr Matls, CN North America, 777 Oakland Ave, Pontiac, MI, 48340 09-20-87
Naglich J A, Matl Insp, Amtrak, 210 S Canal St, Chicago, IL, 60606 04-26-91
Neece J L, Supv Facilities Mtce, CSX Transportation, 1435 Secretariat Dr, Helena, AL, 35080 08-10-83
Nelson W H, Mgr M/W Trng (Ret), BN RR, 965 Winslow, West St Paul, MN, 55118 10-04-82
Nesbitt S A, Sr Strl Engr, Pierce Goodwin Alexander & Linville, 2701 N Rocky Point Dr #500, Tampa, FL, 33607-5920 08-12-81
Newberry A C, Dir Const & Spec Proj, AT&SF RY, 4515 Kansas Ave, Kansas City, KS, 66106 10-04-82
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Oster R R, Architect, UP RR, 1416 Dodge St, Rm 632, Omaha, NE, 68179 02-11-86

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Patel A U, Asst Engr Strs, NS Corp, 99 Spring St SW, Atlanta, GA, 30303-0052 10-20-86
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Patton R D, B&B Supv, NS Corp, 801 S Main Street, Somerset, KY, 42501 09-05-79
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Payne R, President, ESCA Consultants Inc, POB 159- 1606 Willow View, Urbana, IL, 61801 08-28-85
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Price A, Bridge Supv, Alaska RR, PO Box 107500, Anchorage, AK, 99501 11-18-94
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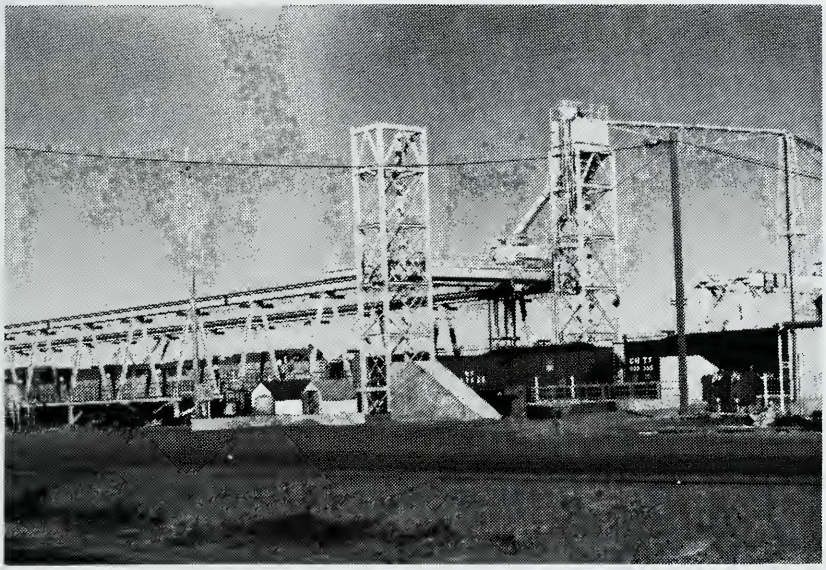

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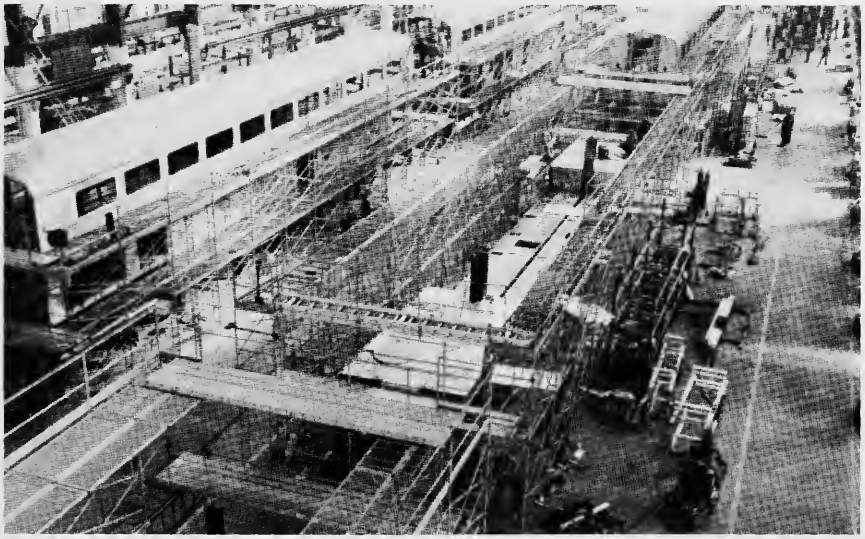

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Wilkerson K E, 7356 Samples Rd, Benton, AR, 72015 02-24-84
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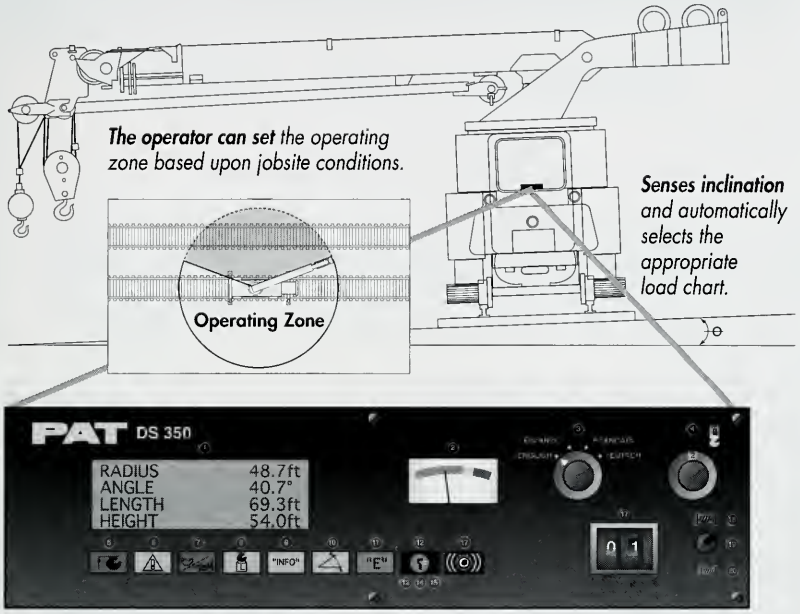

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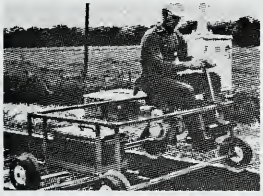

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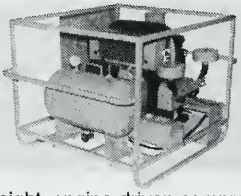

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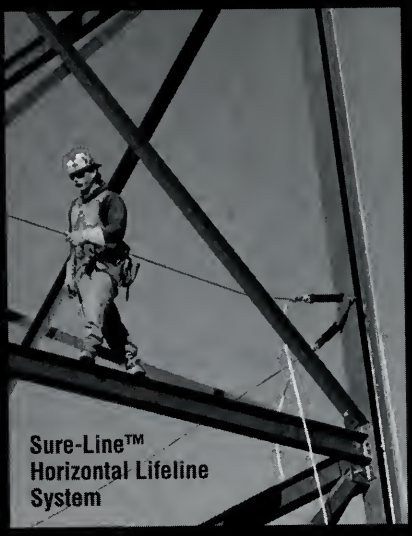

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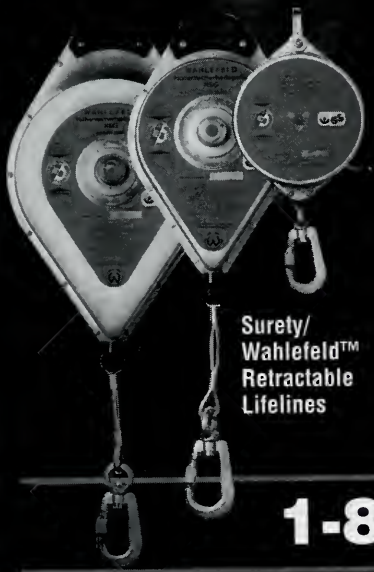

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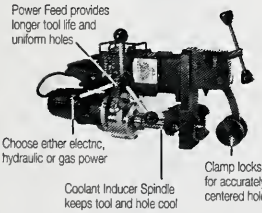
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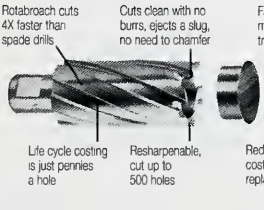
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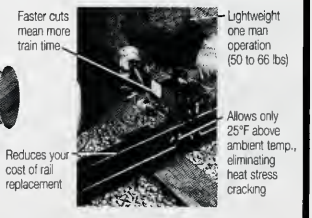
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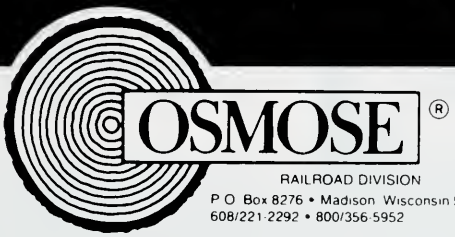

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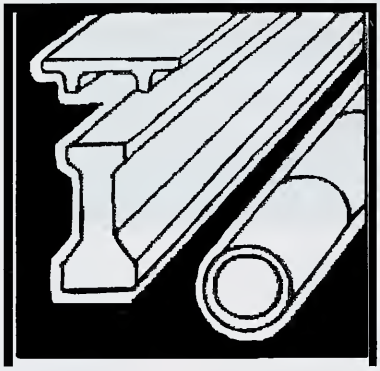

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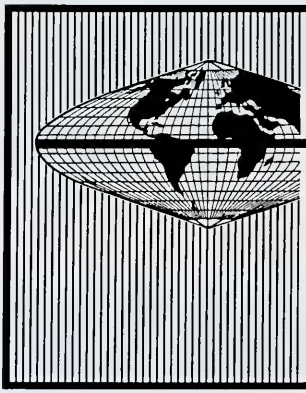

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